Africa Research in Sustainable Intensification for the Next Generation - West Africa

Research in sustainable intensification of cereal-based farming systems in the Guinea-Sudan-Savanna of West Africa

**2021/2022 Research Year Work Plan – Ghana & Mali**

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# Summary

The Africa RISING West Africa (WA) project is being implemented by multi-disciplinary research teams and development partners from the public and private sectors in collaboration with farmers and community-based organizations in northern Ghana.

This document presents the work plans for the 2020-2021 research year for Ghana. The activities and sub-activities are mapped under the four Outcomes in the [Africa RISING West Africa Project Phase 2 logframe](#_Africa_RISING_West). Twenty-eight (34) sub-activities are being implemented in the Ghana workplan, while sixteen (18) are being implemented in the Mali workplan. Table 1 below presents the distribution of the 52 sub-activities per outcome.

**Table 1:** Distribution of sub-activities per West Africa project logframe outcome

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Country** | **Outcome 1** | **Outcome 2** | **Outcome 3** | **Outcome 4** |
| Ghana | 10 | 3 | 6 | 10 |
| Mali | 8 | 1 | 2 | 4 |

Linkages between activities, gender mainstreaming, capacity building, and knowledge exchange and dissemination are embedded within all sub-activity plans. Publication of research results and better communication among research teams within and across countries will be a major focus.

# Background

Phase 1 (1 October 2012 - 30 September 2016) of the USAID-funded Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) project in West Africa (WA) was implemented in 25 intervention communities in northern Ghana and 9 villages in the Bougouni and Koutiala districts of the Sikasso Region in southern Mali under the *title 'Sustainable Intensification of Key Farming Systems in the Guinea-Sudano-Sahelian Zone of West Africa'*. Research activities under Phase 1 were organized around 3 research outputs (ROs), namely: 1) Situation analysis and program-wide synthesis (RO1); 2) Integrated Systems Improvement (RO2) and 3) Scaling and Delivery (RO3). Capacity building and gender were cross-cutting. Phase 2 (1 October 2016-30 September 2021) of the WA project was launched in February 2017.

Technological packages and/or practices validated in Phase 1 (see Table 2) are being scaled out targeting agro-ecosystems and socio-economic circumstances defined by the sustainable intensification (SI) domains - productive, economic, social, human and environmental. Linkages will be established with research and development partners to undertake both generic and back-stopping research. The generic research aims at completing the loose ends of research on the SI innovations in Phase 2 plus any other emerging issues. The back-stopping research will address researchable issues emerging from the scaling-out of SI innovations with the development partners.

Phase 2 is also exploring new research areas emerging from Phase 1 experiences and feedback by research and development partners, notably, using results from farming systems analyses and farm types to inform research targeting and technology dissemination; post-harvest management and value addition; nutrition-sensitive agriculture; labor-saving mechanization solutions for small-scale farmers; and climate-smart agriculture.

# Table 2: **List of validated technologies ready for promotion through development partners in Ghana and Mali**

| **Broad category** | **Validated flagship technology** | |
| --- | --- | --- |
| **Ghana** | **Mali** |
| Introduction of new crops and varieties to overcome existing biotic and abiotic stresses and improve productivity per unit land area. | New varieties – drought-tolerant maize, rice, aflatoxin resistant groundnut, sorghum hybrids, early-maturing cowpea, dual-purpose cowpea, short-duration soybean, medium soybean, high yielding and disease-resistant varieties of improved vegetables (okra, roselle, tomato, eggplant and pepper) | High performing and dry season-adapted and farmer preferred vegetable varieties of okra (Konni), African eggplant (L10), Tomato variety (Rio Grande)  Aflatoxin resistant groundnut, early maturing groundnut  Sorghum hybrids (Pablo, Fadda and Sewa), dual-purpose sorghum (Soubatimi, Tiandougou Coura, Jiguikala and Peke) |
| Agronomic practices to improve grain and fodder yield per land area unit and improve soil nitrogen. | Cereal-legume intercropping  Cereal-legume rotations  Dual-purpose food legumes  Cereal-vegetable intercropping  Cowpea living mulch (Maize cowpea intercrop for NRM and fodder support at household level  Optimal groundnut spacing  Maize leaf stripping for grain and fodder provision. | Cereal-vegetable intercropping (tomato, pepper)  Cereal-legume intercropping (groundnut)  Dual-purpose food legumes |
| Integrated soil fertility management as a cost-effective approach to replenish soil fertility. | Optimized N and P fertilizer rates  Fertilizer micro-dozing  Livestock corralling for manure/urine  Cereal-legume rotations  Cereal-legume intercropping | Fertilizer micro-dosing, composting  Cereal-vegetable intercropping (tomato, pepper)  Cereal-legume intercropping (groundnut) |
| Improved livestock feeds and feeding, housing, health and breeding management packages. | Sheep/goat flock feeding package  Sheep/goat health package  Housing and feeding for poultry  Guinea fowl hatching and brooding management  Stover quality improvement  Improved livestock feed troughs for small ruminants | Stover quality improvement using feed chopper |
| Introduction of pre- and post-harvest technologies to reduce food waste and improve food safety. | Storage-PICS bags, plastic drums  Aflasafe application  Maize shellers for postharvest support |  |
| The use of natural resources management as a means to preserve soil and water. | Soil and water conservation measures (e.g. contour bunding, ridge planting, cowpea living mulch) |  |
| Introduction of improved land and water management systems |  | Contour bunding associated with fast-growing tree species |
| Seed treatment |  | Apron Star 42WS |

# West Africa Project logframe overview

An overview of the Africa RISING West Africa Project logframe up to the activity level can be glanced at in Table 3 below. All sub-activities initiated by project partners align with specific outcomes, outputs, and activities within the logframe. Activities listed in italics within the table have an ongoing sub-activity within this year’s (2021/2022) workplan in Ghana and Mali. For a detailed look at other important logframe elements like objectively verifiable indicators, sources, and means of verification, the assumptions for each output, etc. the complete project logframe document is accessible at: <https://hdl.handle.net/10568/82851>.

# Table 3: Logframe overview (Sub-activity titles in Tables 3.1 & 3.2)

|  |  |  |
| --- | --- | --- |
| **Outcomes, Outputs, and Activities** | | **Ghana Sub-activities for 2021/2022** |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets | |  |
| Output 1.1: Research products for more productive, intensive, diverse, profitable and resilient crops (cereals, legumes, and vegetables); livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners | *Activity 1.1.1: Test and disseminate a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production* | *GH1111-21*  *GH1112-21*  *GH1113-21*  *GH1115-21*  *GH1116-21*  *MA1111-21*  *MA1112-21*  *MA1113-21*  *MA1114-21* |
| *Activity 1.1.2: Test and disseminate a combination of improved breeds, housing, feeding, health and breeding practices to intensify rearing of livestock (sheep, goat, pig, and poultry) for meat, egg and milk production* | *GH1121-21*  *GH1122-21*  *GH1123-21* |
| *Activity 1.1.3: Test and disseminate integrated crop-livestock-soil and agroforestry systems to increase and sustain productivity and reduce risk* | *MA1131-21* |
| Output 1.2: Integrated management practices and innovations to improve and sustain productivity and ecosystems services of the soil, land, water and vegetation resources are developed and disseminated with farmers and development partners in the intervention communities | *Activity 1.2.1: Test and disseminate land, soil and integrated land-soil technologies and practices to improve and sustain productivity and ecosystems services at the farm and landscape/watershed levels* | *GH1211-21*  *GH1212-21*  *MA1211-21*  *MA1212-21* |
| *Activity 1.2.2: Test and promote water management technologies and practices to increase water productivity in the small-scale crop-livestock farming systems under rainfed and irrigated conditions* | *GH1221-21*  *MA1221-21* |
| *Activity 1.2.3: Test and promote integrated soil fertility and integrated pest management technologies and practices to increase and sustain productivity and reduce risk* |  |
| Output 1.3: Labor-saving and gender-sensitive technologies in target areas to reduce drudgery while increasing labor efficiency in the production cycle delivered. | *Activity 1.3.1: Train local partners on the appropriate use of drudgery-reducing technology delivery* |  |
| *Activity 1.3.2: Introduce, test and adapt existing pre-harvest small-scale mechanization options to farmers and partners in the intervention communities* |  |
| *Activity 1.3.3: Demonstrate small-scale maize shelling machines to smallholders and other stakeholders to reduce drudgery and labor requirements* |  |
| Output 1.4: Tools (including ICT-based) and approaches for disseminating recommendations in relation to above research products, integrated into capacity development (and used in outcomes 4 and 5) | *Activity 1.4.1: Generate technology extrapolation domains in West Africa* | *GH1411-21*  *GH1412-21* |
| Outcome 2: More farmers and farm families are adopting technologies and practices to improve nutrition, food and feed safety, post-harvest handling and value addition | |  |
| Output 2.1: Improved technologies, innovations, practices and habits to increase production and consumption of safe diverse and more nutritious food for farm families, especially by women and children developed and disseminated in partnership with research and development partners | *Activity 2.1.1: Develop a nutrition strategy to harmonize the nutrition activities with national nutrition approaches and link them to the crop and livestock activities* |  |
| *Activity 2.1.2: Train farm families, especially women to produce and consume diverse and more nutritious food* | *GH2121-21*  *GH2122-21* |
| *Activity 2.1.3: Use nutrition-focused activities as an entry point for greater involvement of younger women and the youth in the production and consumption of diverse and more nutritious foods* |  |
| Output 2.2: Postharvest technologies and practices to provide options for the food, and feed sectors are tested and disseminated to farmers, through researchers, extension staff, and development partners. | *Activity 2.2.1: Introduce, evaluate, adapt and disseminate existing postharvest technologies and practices* | *GH2211-21*  *MA2221-21* |
| *Activity 2.2.2: Build capacity of farm families to reduce postharvest losses* |  |
| Outcome 3: Farmers and other value chain actors have greater and equitable access to production assets and markets (input and output) through enabling institutions and policies | |  |
| Output 3.1: Enabling policies and institutional arrangements to increase participation of farm families, especially women and youth in the output and input markets and decision-making are advocated for implementation by national governments, policymakers and development partners | *Activity 3.1.1: Review existing policies and institutional arrangements affecting equitable access to production assets and markets* | *GH3111-21*  *GH3112-21*  *MA3112-21* |
| *Activity 3.1.2: Assess the level of inclusiveness of women and the youth along crop and livestock value chains* | *GH3121-21*  *GH3122-21*  *MA3121-21* |
| *Activity 3.1.3: Advocate enabling policies and institutional arrangements to increase participation of farm families, especially women and youth in the output and input markets* |  |
| Output 3.2: Options to expand accessibility of production assets and increase participation in household decision-making by disaggregated groups by gender | *Activity 3.2.1: Identify constraints to, and opportunities for increasing women and youth access to production assets in the target area* | *GH3212-21*  *GH3213-21*  *MA3212-21* |
| Outcome 4: Effective partnerships are built with farmers, local communities, and research and development partners in the private and public sectors to ensure delivery and uptake at scale of SI, technologies, innovations and practices | |  |
| Output 4.1: Alliances and effective partnerships developed between farmers, local communities, and research and development agents in the public and private sectors to enable the release, dissemination, and adoption of proven technologies and practices to scale | *Activity 4.1.1: Conduct cost-benefit and gender analysis coupled with other socio-economic analyses to identify and quantify adoption constraints and opportunities for different farmer contexts* | *GH4111-21*  *GH4112-21*  *GH4113-21*  *GH4115-21*  *MA4111-21* |
| *Activity 4.1.2: Map and assess relevant stakeholders to establish dialogue for the exploration of mutual synergies for scaling delivery of validated technologies* | *GH4121-21*  *GH4122-21* |
| *Activity 4.1.3: Leverage/link and integrate (engagement and outreach) with existent initiatives including Government extension systems to support and encourage the delivery pathways* |  |
| Output 4.2: Gender-sensitive decision support tools to assess technology-associated risks and opportunities are available for use by project partners | *Activity 4.2.1: Identify and communicate gender-sensitive decision support tools in the context of different farm typologies* |  |
| Output 4.3: An updated framework for monitoring technology adoption to be used by the project team and scaling partners available and accessible | *Activity 4.3.1: Monitor and report technologies and their associated beneficiaries or farmers exposed to the innovations using the tools developed by IFPRI* | *GH4311-21*  *GH4312-21*  *GH4313-21*  *MA4312-21*  *MA4313-21* |
| *Activity 4.3.2: Make these reports available on the Africa RISING repositories* |  |
| Output 4.4: Knowledge sharing centers (physical structures) and learning alliances are developed within existing local and regional institutions | *Activity 4.4.1: Establish knowledge-sharing and learning alliances among scaling actors* | *GH4411-21*  *MA4411-21* |

# Table 3.1: Ghana **Sub-activity numbers and titles**

|  |  |  |
| --- | --- | --- |
| Sub-activity | Sub-activity title | Lead |
| GH1111-21 | Follow-up on gender evaluation of cowpea living mulch intervention | IITA |
| GH1112-21 | Optimizing on-farm nitrogen (N) use efficiency under rainfed conditions in maize-based cropping systems | IITA |
| GH1113-21 | Assessing the potential for a combination of local Napier fodder species and pigeon peas for improved soil health, ruminant productivity and market potential of both Napier and Pigeon pea fodder in the Guinea savannah zone; and Investigating opportunities and constraints for fodder cultivation and trade (Napier and Pigeon pea), specifically women’s and youth market participation in this part of the livestock value chain | UDS-FA |
| GH1115-21 | Identify varieties and post-harvest management options of vegetable crop species with adaptation to Northern Ghana in the dry season | WorldVeg |
| GH1116-21 | Determine yield and post-harvest quality of vegetables as affected by improved soil and water management practices in the dry season in Northern Ghana | WorldVeg |
| GH1121-21 | Efficient feed utilization through improved feed troughs | ARI |
| GH1122-21 | Synthesize previous work on feed and health interventions for improved small ruminant production in Northern Ghana | ARI |
| GH1123-21 | Assess the effect of feeding maize leaf stripping on digestibility and growth performance of small ruminants and interactions of the technology with child labor (more specifically herding of small ruminants) and school attendance of boys and girls | UDS-FA |
| GH1211-21 | Assessing buffer and adaptive capacity to harness the resilience of different farm types | WUR |
| GH1212-21 | Assess the impact of soil and water conservation interventions in maize - cowpea living mulch systems | KNUST |
| GH1221-21 | Evaluate the technical and agronomic performance of Bhungroo and solar-energy drip irrigation system in the Upper East Region of Ghana | IWMI |
| GH1411-21 | Produce regionally relevant extrapolation domain maps for validated integrated technology packages | IITA |
| GH1412-21 | Identify the sustainable agricultural intensification technologies and household characteristics that determine the maize grain yields at the different technology extrapolation domains | IITA |
| GH2121-21 | Container gardening training combined with nutrition education for increased vegetable consumption | UDS-SoH |
| GH2122-21 | Engaging Men to Increase Support for Optimal Child Feeding Practices Using Care Group Approach | UDS-SoH |
| GH2211-21 | Evaluate the threshing efficiency of different maize shellers with regards to grain quality characteristics as influenced by different varieties and harvest timing | SARI |
| GH3111-21 | Strengthen the technical, managerial and organizational capacities of the major actors in the small ruminants value chain through existent institutional structures such as Farmer-Based Organizations (FBO), District Assemblies (DA), Community Based Organizations (CBO), traders Associations, Transports and input Dealers Association | ARI |
| GH3112-21 | Analyze the enabling environment including policies and institutional arrangements and intervention to identify factors that enable the inclusion of women and youth along the irrigated vegetable value chain | IWMI |
| GH3121-21 | Assessing the inclusiveness of women and youth within the vegetable production value chain to enhance vegetable production among smallholder farmers. | WorldVeg |
| GH3122-21 | Assess women and the youth participation in maize and small ruminant value chains in project communities and markets the communities are linked to | IITA |
| GH3212-21 | Co-identify value chain-based scaling pathways for irrigation technologies and water solutions with farmers and other actors of vegetable value chains in the Africa RISING sites in Mali and Ghana and link these sites and activities to ILSSI’s multi-stakeholder Dialogue Space on small scale irrigation in Ghana | IWMI |
| GH3213-21 | Sustainable agricultural intensification, resilience capacity, and food security among smallholder farmers | IITA |
| GH4111-21 | Conduct simulation and other socio-economic analyses of selected SI technologies/practices for different farmer contexts, to have a better understanding of the adoption potential of these proven technologies and opportunities for scaling up. | STEPRI |
| GH4112-21 | Evaluate the impact of SI practices on household welfare, poverty, perceived shock, the environment, and food and nutrition security in northern Ghana | IITA |
| GH4113-21 | Provide safety nets to smallholder farmers through crop insurance while developing a business model with multi-stakeholder partners for scaling validated technologies for equity and empowerment | IITA |
| GH4115-21 | The impact of smallholder Agricultural commercialization on household income and nutrition in Ghana and Malawi | IITA |
| GH4121-21 | Utilize ICT and GIS tools as a means to share information (agronomic, climatic and market services) and scale-out Africa RISING technologies in collaboration with strategic partnerships in the region | KNUST  IITA |
| GH4122-21 | Promotion and dissemination of Africa RISING SI interventions for sustained productivity and reduced risk in Ghana using the climate-smart village approach | SARI |
| GH4311-21 | Matching agricultural technologies to farms and their context | WUR |
| GH4312-21 | Investigate the distribution of benefits from diverse agricultural interventions | WUR |
| GH4313-21 | Addressing constraints limiting the adoption of SI technologies as a result of competing interests for natural and other household resources | SARI |
| GH4411-21 | Scaling of Africa RISING crop-livestock technologies beyond the intervention sites in northern Ghana: The Innovation Research Extension Advisory Coordination Hubs (i-REACH) model | IITA |

# Table 3.2: Mali Sub-activity numbers and titles

|  |  |  |
| --- | --- | --- |
| Sub-activity | Sub-activity title |  |
| MA1111-21 | Evaluating crop simulation models using different fertility sources and climate model outputs to improve the productivity of sorghum | ICRISAT |
| MA1112-21 | Understanding soil fertility management in cereal cropping systems in southern Mali | ICRISAT |
| MA1113-21 | Testing adaptation of dual-purpose sorghum hybrids in Mali to diversify options for crop-livestock integration | ICRISAT |
| MA1114-21 | Evaluate and disseminate diseases, pests, postharvest and nutrition support technologies tested in 2019 to reduce pre-and postharvest losses and improve nutrition under rainfed and dry seasons | WorldVeg |
| MA1131-21 | Risk management and informed decision making towards sustainable intensification of crop-livestock systems | WUR |
| MA1211-21 | Assess cropping management factors using empirical relations, GIS and Remote Sensing tools in two agro-ecologies of Mali | ICRISAT |
| MA1212-21 | Improving crop-livestock productivity and household income through the use of contour bunding and agroforestry options | IER |
| MA1221-21 | Evaluate improved irrigation technologies for efficient and sustainable agricultural water management in rural Mali | ICRISAT |
| MA2211-21 | Reduce vegetable postharvest losses through the dissemination of Zero Energy Cool Chamber (ZECC) and processing of vegetables and capacity building in the dry season in Bougouni and Koutiala | WorldVeg |
| MA3112-21 | Analyze the enabling environment including policies and institutional arrangements and intervention to identify factors that enable the inclusion of women and youth along the irrigated vegetable value chain | IWMI |
| MA3121-21 | Assessing the inclusiveness of women and youth within the vegetable production value chain to enhance vegetable production among smallholder farmers | WorldVeg |
| MA3212-21 | Co-identify value chain-based scaling pathways for irrigation technologies and water solutions with farmers and other actors of vegetable value chains in the Africa RISING sites in Mali and Ghana and link these sites and activities to ILSSI’s multi-stakeholder Dialogue Space on small scale irrigation in Mali | IWMI |
| MA4111-21 | Determine farmers’ preferences of technology attributes in cereal-legume systems of southern Mali | ICRISAT |
| MA4312-21 | Assess the impact of Innovation Platforms on SI technology uptake in Africa RISING interventions communities | AMEDD |
| MA4313-21 | GIS mapping of implemented technologies across different agro-ecologies and gender influence in technology adaptation and use in Bougouni and Koutiala districts of Mali | AMEDD |
| MA4411-21 | Manage the operations of four technology parks as hubs for research and demonstration in Bougouni and Koutiala | ICRISAT |

# Table 4. Ghana and Mali Partners and their responsibilities

| **Name** | **Abbreviation** | **Ghana** | **Mali** | **Role/responsibility** |
| --- | --- | --- | --- | --- |
| **Government Ministries & Entities** |  |  |  |  |
| Ministry of Food and Agriculture | MoFA | + |  | Scaling-out SI technologies and establishment of R4D platforms |
| Ministry of Health (Ghana Health Services) | MoH (GHS) | + |  | Household nutrition R4D with UDS and IITA; Assist with training of women’s groups on nutrition education, data collection & compilation of reports on activities |
| Ghana Irrigation Development Authority | GIDA | + |  | Potential scaling partner for irrigation technologies with IWMI |
| Veterinary Services Division | VSD | + |  | Animal health, capacity building community health workers with Animal Research |
| Institut d’Economie Rurale | IER |  | + | Socioeconomic and on-farm studies with ICRISAT |
| **Academic/National Research Institutions** |  |  |  |  |
| University for Development Studies | UDS | + |  | Research on livestock nutrition and human nutrition, Graduate training and R4D |
| Science and Technology Policy Research Institute | STEPRI | + |  | Policy review and analysis |
| Institut Polytechnique Rural de Formation et de Recherche Appliquée Katibougou | IPR-IFRA |  | + | Polytechnic for rural education and applied research |
| Kwame Nkrumah University of Science and Technology | KNUST | + |  | Graduate student training, research on soil water dynamics |
| Animal Research Institute | ARI | + |  | R4D on livestock production (sheep and goats) with ILRI |
| **International Research Institutions** |  |  |  |  |
| International Crops Research Institute for the Semi-arid Tropics | ICRISAT | + | + | Sorghum/millet-groundnut R4D with IITA and SARI |
| International Food Policy Research Institute | IFPRI | + | + | Surveys, and monitoring and evaluation |
| The World Vegetable Center | WorldVeg | + | + | Lead R4D on vegetable production systems |
| International Institute of Tropical Agriculture | IITA | + | + | Project coordination and R4D research on cereal-legumes. |
| International Water Management Institute | IWMI | + |  | Lead R4D on water management |
| Wageningen University, The Netherlands | WUR | + | + | R4D on farming systems and graduate training |
| Alliance Bioveristy CIAT | ABC | + |  | Research on land and soil management |
| **Nongovernmental Organizations** |  |  |  |  |
| Fédération Nationale pour l'Agriculture Biologique et Équitable | FENABE |  | + | Scaling-out, capacity building, community mobilization, on-farm research |
| Association Malienne d’Eveil et de Développement Durable | AMEDD |  | + | On-farm field trials and household nutrition studies with ICRISAT |
| **Private Organizations and Development Projects** |  |  |  |  |
| Community-based Organizations | CBOs | + | + | On-farm implementation of R4D activities |
| Seed Producers Association of Ghana | SEEDPAG | + |  | Seed production and training of farmers for quality declared seed |
| WorldCover | WorldCover | + |  | Indexed based agricultural insurance. Co-sharing of farmers in some communities provides synergies. |
| ESOKO | ESOKO | + |  | to share and disseminate information on proven agronomic practices as well as on the seasonal calendars |
| **Feed the Future Innovation Labs** |  |  |  |  |
| Sustainable Intensification Innovation Lab | SIIL | + |  | Co-share materials, concepts and approaches to conducting research e.g. use of the Sustainable intensification Framework |
| Soybean Innovation Lab | SIL | + |  | Sharing knowledge and approaches towards post-harvest mechanization in communities |
| Innovation Lab for Small Scale Irrigation | ILSSI | + |  | Co-location of sites with Africa RISING work and sharing knowledge, approaches, sites and personnel e.g. with IWMI |

## Ghana Planned work

The planned activities are presented in the protocols. Activities under each protocol are aimed at achieving the outputs under the four outcomes in the project logframe (Table 3).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Africa RISING West Africa Activity Protocol – Outcome 1: GH1111-21** | | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | | | |
| a. Output 1.1 | | | Research products for more productive, intensive, diverse, profitable and resilient crops (cereals, legumes, vegetables), livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through the development partners in the intervention communities | | | | | | | | | | | |
| b. Activity 1.1.1 | | | Test a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production | | | | | | | | | | | |
| c. Sub-activity GH1111-21 | | | Follow-up on gender evaluation of cowpea living mulch intervention | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | |
| Name | | | | | Institution | | | | Role | | | | | |
| Gundula Fischer | | | | | IITA | | | | Social scientist, activity leader, development of tools and data analysis | | | | | |
| Kipo Jimah | | | | | IITA | | | | Gender specialist, development of tools, data collection, and data analysis | | | | | |
| Abdul Rahman Nurudeen | | | | | IITA | | | | Agronomist, assessment of productivity dimension | | | | | |
|  | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | | Degree | | Start | | End |
| Nil | | | |  | | | | | |  | |  | |  |
|  | | | | | | | | | | | | | | |
| f. Location(s) | |  | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| g. Start | | October 2017 | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| h. End | | June 2022 | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | |
| In 2019 the Africa RISING gender team evaluated the cowpea living mulch intervention with men and women farmers. Quantitative and qualitative data have been processed. In 2021 a follow-up study was implemented with the following objectives: to validate the results of the 2019 study (specifically to seek clarification on labor roles) and to fill data gaps for the cowpea living mulch modeling paper (Sub-activity GH1111-19). Both quantitative and qualitative data of the follow-up investigation have been processed. Overall analysis and write-up of results have to be completed. | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | |
| 2.1 To complete data processing, analysis, and write up of results of this sub-activity | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | |
| 3.1 What are the gendered household labor roles that shape the application of cowpea living mulch technology? | | | | | | | | | | | | | | |
| 3.2 How do gendered labor investments and benefits differ in household fields compared to individual fields concerning the cowpea living mulch technology? | | | | | | | | | | | | | | |
| 3.3 What are the adaptations needed to facilitate the adoption of the cowpea living mulch technology? | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | |
| No new data collected | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded | | | | | | | | | | | | | Responsibility | |
| 5.1 Upload of quantitative data of the follow-up study | | | | | | | | | | | | | IITA | |
|  | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | End date | | |
| 6.1 Analyzed qualitative data | | | | | | | Transcriptions | | | | | Feb. 2022 | | |
| 6.2 Working paper/report | | | | | | | Publication on CGSpace | | | | | Aug. 2022 | | |
| 6.3 Contribution to WA handbook | | | | | | | Final version submitted and approved by the chief scientist | | | | | Throughout the year | | |
|  | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | |
| **Domain** | **Indicators** | | | | | **Metric & Scale** | | **The approach used in data collection** | | | **Before intervention** | | | **After intervention** |
| 7.1 Productivity |  | | | | |  | |  | | |  | | |  |
| 7.2 Environmental |  | | | | |  | |  | | |  | | |  |
| 7.3 Economic |  | | | | |  | |  | | |  | | |  |
| 7.4 Social | * -Labor roles * -Drudgery scores | | | | | Household | | * Survey * KII | | |  | | |  |
| 7.5 Human |  | | | | |  | |  | | |  | | |  |
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| 8. How will scaling be achieved? |
| The findings of the comprehensive study will inform discussions and decisions on gender-responsive strategies and practices to be chosen for dissemination. The results of these processes will be communicated to development partners for scaling. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| Paper: Cowpea living mulch effect on maize yield and soil quality in northern Ghana- Under review by Agriculture, Ecosystem, and Environment (Nurudeen Abdul Rahman) |
| Paper: Systems Dynamics Modelling for smallholder farmers in Northern Ghana: The case for the Cowpea Living mulch system- Under internal review (Fred Kizito, Nurudeen Abdul Rahman, Gundula Fischer, Jimah Kipo, Bekele Kotu) |
| 10. Custom indicators |
| * Technical report on gender cowpea living-mulch evaluation * Handbook Chapter |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  The cowpea living mulch intervention addresses food insecurity, natural resource management, and climate change adaptation. This sub-activity will complement the biophysical research by informing policymakers about gender issues surrounding the adoption of the cowpea living mulch technology. |
| 11.2 Who is your target audience, e.g., extension agents, farmers, or policymakers?  The study mainly targets smallholder farmers in Africa RISING intervention areas and extension officers. |
|  |
| 12. Budget |
| No operational budget needed |

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| 13. Gantt chart | | | | | | | | | |
| Year/ month | 2021 | | | 2022 | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
| Data analysis |  |  |  |  |  |  |  |  |  |
| Write up of results |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 1: GH1112-21** | | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | | | |
| a. Output 1.1 | | | Research products for more productive, intensive, diverse, profitable and resilient crops (cereals, legumes, vegetables), livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities | | | | | | | | | | | |
| b. Activity 1.1.1 | | | Test a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production | | | | | | | | | | | |
| c. Sub-activity GH1112-21 | | | Optimizing on-farm nitrogen (N) use efficiency under rainfed conditions in maize-based cropping systems | | | | | | | | | | | |
|  | | |  | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | |
| Name | | | | | Institution | | | | Role | | | | | |
| Abdul Rahman Nurudeen | | | | | IITA | | | | Leader: Cereal agronomy and plant nutrition | | | | | |
| Bekele Kotu | | | | | IITA | | | | Economic analysis | | | | | |
| Gundula Fischer/Kipo Jimah | | | | | IITA | | | | Gender studies | | | | | |
| Francis Muthoni | | | | | IITA | | | | GIS input | | | | | |
| George Mahama | | | | | SARI | | | | Climate change specialist | | | | | |
| Benedict Boyubie | | | | | IITA | | | | Uploading of data onto PMMT and Dataverse | | | | | |
|  | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | | Degree | | | Start | End |
| NIL | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| f. Location(s) | | Northern (Tingoli, Cheyohi no. 2, Doku, Tibali), Upper East (Samboligo, Nyangua, Gia, Bonia), Upper West (Zanko, Guo, Goli, Goriyiri) regions | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| g. Start | | June 2019 | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| h. End | | August 2022 | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | |
| Maize is a heavy demander of plant nutrients, especially nitrogen (N). Grain yields on farmers’ fields are low due to declining soil fertility. The application of inorganic fertilizer is responsible for large per capita food production in most parts of the world (Sanchez *et al*., 1997[[1]](#footnote-2); World Bank, 2017[[2]](#footnote-3)). The Government of Ghana’s flagship program on Agriculture (Planting for food and jobs) promoted a new fertilizer mixture (15-20-20 kg/ha NPK + S + MgO + Zn) for cereals (maize, rice, and sorghum) for the 2019 cropping season. However, there is limited evidence on the quality and efficacy of this new fertilizer mixture compared to the best compound fertilizer in the market (YARA Actyva; 23-10-5 NPK + S + MgO + Zn). Following up on initial field activities conducted in 2019, this study will again determine the effect of the fertilizer type and management practices on maize growth, yield, and N use efficiency under on-farm conditions. This study builds on the results from Africa RISING experiments of N fertilizer rates and variety effect on maize grain yield in northern Ghana (Africa RISING technical report March 2015 and 2016) to apply N fertilizer at 90 kg/ha. The results from this new study would provide empirical evidence to inform policymakers on the effectiveness of the proposed new fertilizer mixture. This study was started in 2019 with a field experiment and considering the application of the Sustainable Intensification Assessment Framework (SIAF) which has 5 (Productivity, Economic, Environment, Human and Social) domains, The data collected covers the productivity, human and social domains only. Therefore, there is the need for a year extension of the study to complete data collection in the environmental and economic domains to enable the successful application of the SIAF to evaluate the sustainability of the technology. | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | |
| 2.1 Determine the effect of fertilizer type and time of its application on the growth and yield of maize | | | | | | | | | | | | | | |
| 2.2 Evaluate gender preferences for fertilizer type and time of its application practices | | | | | | | | | | | | | | |
| 2.3 Assess the sustainability of the technology and its impact on the wellbeing and livelihoods of smallholder farmers | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | |
| 3.1 How does fertilizer type and time of its application affect maize growth, yield, and N use efficiency? | | | | | | | | | | | | | | |
| 3.2 What are the gender preferences for fertilizer type and time of its application practices? | | | | | | | | | | | | | | |
| 3.3 How sustainable is the fertilizer type and the time of its application on the wellbeing of the smallholder maize farmers through its impact on income, food security, and gender equity? | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | |
| Laboratory analysis of plant samples (grain and stover) from the agronomic trials (GH1112-20) will be done for NPK nutrient uptake to compute the partial nutrient budget. A follow-up survey will be conducted with farmers who hosted the agronomic trials on their 1-acre fields (Upscaling) to collect data on labor rating and cost of labor for key agronomic practices and inputs to calculate net income and return to labor. | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded | | | | | | | | | | | | Responsibility | | |
| 5.1 Maize grain yield and N use efficiency | | | | | | | | | | | | Nurudeen Abdul Rahman, IITA | | |
| 5.2 Net income and return to labor | | | | | | | | | | | | Bekele Kotu, IITA | | |
| 5.3 Soil nutrient partial budget | | | | | | | | | | | | Nurudeen Abdul Rahman, IITA | | |
| 5.4 Greenhouse gas (GHG) emission | | | | | | | | | | | | George Mahama/ SARI | | |
| 5.5 Farmer preference for technology | | | | | | | | | | | | Nurudeen Abdul Rahman, IITA | | |
| 5.6 Labor roles and drudgery scores for technology | | | | | | | | | | | | Gundula Fischer, Kipo Jimah, IITA | | |
| 5.7 Uploading of data onto Dataverse | | | | | | | | | | | | Benedict Boyubie/ IITA | | |
|  | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | | End date | |
| 6.1 Data on income and return to labor | | | | | | | Biannual technical report | | | | | | Mar 2022 | |
| 6.2 Technology brief | | | | | | | Cgspace | | | | | | Jul 2022 | |
| 6.3 Journal publication | | | | | | | Web of Science Master List journal | | | | | | Aug 2022 | |
| 6.4 WA handbook contributions | | | | | | | Contributions submitted and approved by chief scientist | | | | | | Throughout the year | |
|  | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | |
| Domain | Indicators | | | | | Metric & Scale | | Approach used in data collection | | | Before intervention | | | After intervention |
| 7.1 Productivity |  | | | | |  | |  | | |  | | |  |
| 7.2 Environmental | N partial budget | | | | | Field/plot | | Laboratory analysis | | | Control treatment | | | About 5% increase for new technology |
| 7.3 Economic | * Net income * Return to labor | | | | | Field/plot | | Survey | | | Control treatment | | | 5-10% increase for new technology |
| 7.4 Social | * Labor roles * Drudgery scores | | | | | Household | | Survey | | | Control treatment | | |  |
| 7.5 Human |  | | | | |  | |  | | |  | | |  |

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| --- | --- |
| 8. How will scaling be achieved? | |
| Scaling will be achieved through strategic partnerships with private sector partners such as SeedPAG, Degas, and GAIP. Knowledge transfer and scaling strategies will include: the establishment of research-for-development plots to demonstrate technologies; participatory and joint learning approaches for technology testing and dissemination, e.g., Community-based Technology Parks and establish Innovation Research Extension Advisory Coordination Hubs (i-REACH); development of media materials (posters, leaflets, films) for extension staff, farmers, etc.; exchange visits for farmers and researchers; training of trainers and hands-on training for farmers. | |
|  | |
| 9. How are the activities in this protocol linked to those of others? | |
| This sub-activity is linked with maize leaf stripping feeding trial (GH3211-21) and Monitor and report technologies and their associated beneficiaries or farmers exposed to the innovations using the tools developed by IFPRI (New). | |
|  | |
| 10. Custom indicators | |
| • Extent of responsiveness on Project performance through the semi-annual reports  • Number of Technology briefs released  • Number of Journal articles published | |
|  | |
| 11. Impact-based summary matrix | |
| 11.1 What is the development challenge you are addressing?  Food insecurity, natural resource management, and climate change adaptation.  This sub-activity will address the following major development challenges. (I) food insecurity, (ii) the sub-activity will also reduce the negative effects of climate change and variability on crop productivity, (iii) it will also increase farmers adaptive capacity to climate change and contributes to increasing crop productivity in the area, and (iv) increased productivity can also contribute to a profitable crop enterprise thereby improving household income. | |
| 11.2 Who is your target audience, e.g., extension agents, farmers, or policymakers?  Farmers, extension agents, and policymakers | |
|  | |
| 12. Budget | |
| Costs | IITA |
| Personnel | 75,000 |
| Services | 2,000 |
| Supplies |  |
| Capital |  |
| Travel | 2,000 |
| Overhead |  |
| Total | 79,000 |

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| 13. Gantt chart | | | | | | | | | | | | | | |
| Year/ Month | 2021 | | | | | | 2022 | | | | | | | |
| Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
| Tool development |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Training of enumerators |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Data collection |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Laboratory analysis of plant samples |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Data processing and analysis |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Semi-annual report |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Technology brief |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Journal publication |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 1: GH1113-21** | | | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | | | | |
| a. Output 1.1 | | | Research products for more productive, intensive, diverse, profitable and resilient crops (cereals, legumes, vegetables), livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities | | | | | | | | | | | | |
| b. Activity 1.1.1 | | | Assessing the potential for a combination of local Napier fodder species and pigeon peas for improved soil health, ruminant productivity and market potential of both Napier grass and pigeon pea fodder in the Guinea savannah zone; and Investigating opportunities and constraints for fodder cultivation and trade (Napier and Pigeon pea), specifically women’s and youth market participation in this part of the livestock value chain | | | | | | | | | | | | |
| c. Sub-activity GH1113-21 | | | Assessing the potential for a combination of local Napier fodder species and pigeon peas for improved soil health, ruminant productivity, and market potential of both Napier grass and pigeon pea fodder in the Guinea savannah zone and Investigating opportunities and constraints for fodder cultivation and trade (Napier and Pigeon pea), specifically women’s and youth market participation in this part of the livestock value chain  (Follow-up on ensiling Napier grass/Pigeon pea for feeding livestock) | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | | |
| Name | | | | | Institution | | | | Role | | | | | | |
| Terry Ansah | | | | | UDS | | | | Animal Nutritionist and forage science, Cultivate Napier/Pigeon pea and Ensile | | | | | | |
| Fred Kizito | | | | | IITA | | | | Contributing in the analysis and lead in incorporating soil health attributes: soil and water conservation in the fodder cultivation | | | | | | |
| Abdul Rahman Nurudeen | | | | | IITA | | | | Input on agronomic aspects of pigeon pea intercrop with pastures | | | | | |
|  | | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | | Degree | | Start | | End | |
| Emmanuel Aifirfa | | | | UDS | | | | | | Mphil | | 2020 | | 2022 | |
|  | |  | | | | | | | | | | | | | |
| f. Location(s) | | Northern Region (Savelugu District-Duko Technology Park) | | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | | |
| g. Start | | August 2021 | | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | | |
| h. End | | April 2022 | | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | | |
| This sub-activity was initially conducted in the year 2019/2020, 2020/21 and is now being conducted for the third season to verify findings from the previous year. In addition, a new related sub-activity linking to Outcome 3 (GH3112-20) on the marketing potential of the fodder from Napier grass and pigeon pea in the Guinea savannah zone has been added. For the year 2021/2022 a related sub-activity is being proposed to assess the prospects of ensiling Napier grass/pigeon pea among smallholder farmers. This was based on an observation made during the time of harvesting when most farmers left large quantities of fodder on the field due to lack of storage space. Natural pasture or rangeland remains the single most important source of forage for ruminants in most developing countries. Rangeland occupies about 54% of the terrestrial ecosystems and sustains approximately 30% of the world’s population (Reynolds et al., 2007[[3]](#footnote-4); Estell et al., 2012[[4]](#footnote-5)). An increase in urbanization and competition for land are major threats to the availability of rangelands for livestock production (Oba, 2013[[5]](#footnote-6)). In addition, the adoption of policies that favor crop production over the maintenance of pasture is also gradually reducing the area of land for grazing livestock. It has been estimated that almost 75% of rangelands have been lost to desertification and soil degradation (UNCCD, 2009[[6]](#footnote-7)). It has been observed that in the wet season, access to fodder from rangeland is often limited due to the extensive cultivation of food crops. This affects the productivity of farm animals which will ultimately affect household food security and income.  The introduction of farmers to the cultivation of fodder in the rainy season could augment the supply of biomass and nutrients from crop residues and would reduce the distance often covered by animals to access fodder from natural sources. The number of children who are often involved in sending animals out for grazing at the expense of their education will be reduced. Conflicts associated with crop destruction by farm animals in the rainy season will be minimized. Milk yield from lactating cows in Ghana is relatively low and this has been attributed to the low potential of the breeds of cattle and most importantly the problem of inadequate nutrition (Digestible protein and metabolizable energy). Inadequate nutrition could also account for a shorter length of lactation in animals leading to a reduced milk yield. The consumption of milk, especially among children from cows is very common in most households that keep cows. It has the potential to reduce child malnutrition. Other small ruminant species also play a very important role in ensuring household food security and income.  The survival and productivity of different grass species could be influenced by origin, temperature, light intensity, total rainfall, soil type, fertilization level, and stage of maturity. This makes the selection of suitable fodder species for ruminant livestock production very critical.  Napier grass (*Pennisetum purpureum*), is a high-yielding perennial grass native to most African countries including Ghana. Yield is even much higher in areas with a regular supply of water. Annual yields of 85.4 t of dry matter (DM) per ha without fertilizer and up to 130 t DM per ha with 1,320 kg/ha of nitrogen (N) fertilizer have been recorded (Boonman, 1993[[7]](#footnote-8)). The yield of Napier grass can be affected by geographical location, which is largely influenced by temperature, rainfall, and N supply (Minson, 1990[[8]](#footnote-9)). Ansah et al. (2010[[9]](#footnote-10)) reported yields ranging from 4,863 kg/ha to 44,994 kg/ha of DM in the humid zone of Ghana. In Duko, an Africa RISING community in the dry savanna zone of Ghana, Cudjoe et al. (2017[[10]](#footnote-11)) reported biomass yields in the range of 1,354 kg DM/ha to 3,339 kg DM/ha with the local variety possessing superior qualities. Napier grass has also been found to be the most effective barrier grass in controlling soil erosion in maize farms in Kenya (Mutegi et al., 2008[[11]](#footnote-12)). In addition, the combination of Napier grass with legumes has been reported to increase water stored in the crop root zone (Kizito et al., 2016[[12]](#footnote-13)). We intend to use a dual-purpose legume, pigeon pea (*Cajanus cajan*) which serves as food for farming families and feed for livestock. Although agronomic trials of Napier have been conducted in Ghana, very little has been done on the effect of intercropping *Cajanus cajan* with Napier in the dry savanna zone of Ghana. The rationale for the location of this trial in Duko is that there is an irrigation facility that will permit for testing the performance of irrigated fodder out of season. This study will help provide better insights into the advantages of the association of Napier grass and pigeon pea. The addition of pigeon pea could potentially help respond to questions that link Africa RISING work to the Innovation Lab for Legume Systems Research. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | | |
| 2.1 Validate the growth characteristics of the local Napier grass intercropped with or without *Cajanus cajan* | | | | | | | | | | | | | | | |
| 2.2 Determine the ensiling potential of Napier grass/*Cajanus cajan* fodder | | | | | | | | | | | | | | | |
| 2.3 Determine the nutrient composition ensiled Napier grass/*Cajanus cajan* fodder | | | | | | | | | | | | | | | |
| 2.4 Determine the feed intake of ensiled Napier grass/*Cajanus cajan* fodder | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | | |
| 3.1 Can Napier grass be ensiled with or without *Cajanus Cajan* fodder without affecting nutrient composition? | | | | | | | | | | | | | | | |
| 3.3 Can Napier grass be ensiled with or without *Cajanus Cajan* fodder without affecting in vitro digestibility? | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | | |
| The experimental plots for the cultivation of Napier grass and pigeon pea will be laid in a completely randomized block design. The study will be conducted at the Africa RISING Technology Park in Duko. Similar to the previous methodology, nine small ruminant farmers will be selected. The rationale for the location of this trial in Duko is that there is an irrigation facility that will permit for testing the performance of irrigated fodder out of season.  **Cultivation of Napier grass and feeding trial:**  The small ruminant farmers (9) will be randomly assigned to 36 plots each measuring 0.25 acres. An area of 0.25-acre will be cultivated at a distance of 0.5 by 0.5m between plants. The pigeon pea will be introduced after every row of Napier grass at a planting distance of 1 by 1m.  The Napier grass will be allowed 8 weeks to establish during which data on plant height, tiller number, stem diameter will be taken. The grass will be harvested 8 weeks after planting and biomass yield determined. Subsequent harvests will be done at 4 weeks intervals during the rainy season.  Two weeks after planting the Napier grass, pigeon pea will be introduced into the field. Data will be collected on germination, date to flowering, plant height, and grain yield. Fodder yield from the pigeon pea will be estimated.  The nutrient composition (DM, CP, NDF, ADF, Ash) and in vitro digestibility of the harvest fodder in both Napier grass and pigeon pea will be determined.  **Effect of sole Napier grass or intercrop on the soil:**  Before the planting of the forages, some soil physio-chemical properties in the upper 0-15 cm of the soil will be measured. An access tube will be installed in each plot to monitor soil moisture variations while runoff detectors will be installed in block to monitor soil losses. Soil accumulation, soil losses, soil moisture, percentage soil cover will be measured on all plots.  **Ensiling of Napier grass/*Cajanus cajan***  Three bunker silos will be constructed in Duko as a demonstration site for the farmers. The silo will be made of wood lined with plastic sheets to ensure air is eliminated. The grass will be harvested and ensiled with or without *Cajanus cajan.* After about 100 days of ensiling, the silos will be opened, and samples will be taken for chemical composition and in vitro digestibility.  ***Data analysis:***  Napier grass and *Cajanus cajan*  The data from the agronomic trial, grain yield, and ensiled fodder quality will be analyzed by ANOVA. The performance of sole Napier grass and sole pigeon pea will be compared to the intercrop. The grain yield from the pruned and unpruned pigeon pea will be compared. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded | | | | | | | | | | | | | Responsibility | | |
| 5.1 Growth characteristics and ensiling, nutrient composition and digestibility | | | | | | | | | | | | | UDS | | |
| 5.2 Soil health (soil losses, soil moisture) | | | | | | | | | | | | | IITA | | |
|  | | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | End date | | | |
| 6.1 Mini silos constructed by farmers | | | | | | |  | | | | | Nov. 2021 | | | |
| 6.2 Napier grass and pigeon pea fodder ensiled | | | | | | | Field report | | | | | Nov. 2021 | | | |
| 6.3 Chemical composition and digestibility analysis of ensiled forage | | | | | | | Field report | | | | | Jul. 2022 | | | |
| 6.4 Data analysis and manuscript write up | | | | | | | Manuscript submitted to chief scientist | | | | | Aug. 2022 | | | |
| 6.5 Contribution to the WA handbook of technologies | | | | | | | Final contribution submitted and approved by chief scientist | | | | | Mar. 2022 | | | |
|  | | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | | |
| Domain | Indicators | | | | | Metric & Scale | | Approach used in data collection | | | Before intervention | | | After intervention | |
| 7.1 Productivity | Crop biomass productivity (Napier and pigeon pea),  Silage and feeding value | | | | | Forage yield at plot/field level/season  (kg/ha/season)  Forage ensiled | | Experimental plots, laboratory analysis  Volume of forage ensiled | | | 0 | | |  | |
| 7.2 Environmental | Erosion | | | | | Soil loss (t/ha/season at plot level,  Rating of erosion | | Field measurements,  Participatory exercises | | | 0 | | |  | |
| 7.3 Economic | Market Participation (potential) of fodder | | | | | Acceptability and barriers to adoption at community level | | Interview/surveys or participatory exercises | | | 0 | | |  | |
| 7.4 Social | Gender market participation | | | | | Participation in a collective action group | | Interviews/surveys | | | 3 women and 6 male | | |  | |
| 7.5 Human | Animal production | | | | | Animal fed with Napier and Pigeon pea fodder silage/ household | | Experimental plots/ Farmer responses | | | 8 small ruminants per household | | |  | |

|  |
| --- |
| 8. How will scaling be achieved? |
| Scaling will be achieved through MoFA and NGOs working in the livestock sector as well as linking to the Research Extension Linkage Committees (RELCs) for the Savelugu District. In addition, since the trial will be conducted in a Technology Park, we anticipate that visitors coming to this park and the participatory and joint learning approaches from the technology testing will allow for the scaling of fodder banks within farming communities. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| This activity links with previous work on soil and water conservation (GH1111- 20 and GH1212- 20) in relation to livestock feeding activities The activity will leverage previous training of farmers in ensiling of crop residues. |
|  |
| 10. Custom indicators |
| * Journal Paper * Conference proceedings |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  The sub-activity seeks to deal with the problem of fodder wastage observed among farmers in the previous study |
| 11.2 Who is your target audience, e.g., extension agents, farmers, or policymakers?  Crop/livestock farmers |

|  |  |  |
| --- | --- | --- |
| 12. Budget (US$) | IITA (will not be disbursed to UDS) | UDS |
| Personnel | 0 | 10,000 |
| Services | 2,000 |  |
| Supplies | 2,000 | 5,000 |
| Capital | 1,000 | 0 |
| Travel | 1,000 | 4,000 |
| Overhead | 0 | 2,850 |
| Total | 6,000 | 21, 850 |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 133. Gantt chart | | | | | | | | | | |
| Year | 2021 | | | | | 2022 | | | | |
| Month | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May |
| Field establishment |  |  |  |  |  |  |  |  |  |  |
| Monitoring moisture |  |  |  |  |  |  |  |  |  |  |
| Monitoring of forage and Pigeon pea growth trends |  |  |  |  |  |  |  |  |  |  |
| Soil health (soil moisture trends) |  |  |  |  |  |  |  |  |  |  |
| Data collection |  |  |  |  |  |  |  |  |  |  |
| Ensiling of fodder |  |  |  |  |  |  |  |  |  |  |
| Chemical composition and In vitro digestibility |  |  |  |  |  |  |  |  |  |  |
| M&E for verification |  |  |  |  |  |  |  |  |  |  |
| Journal article preparation (including last years’ data) |  |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 1: GH1115-21** | | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | | | |
| a. Output 1.1 | | | Research products for more productive, intensive, diverse, profitable and resilient crops (cereals, legumes, vegetables), livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities | | | | | | | | | | | |
| b. Activity 1.1.1 | | | Test a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production | | | | | | | | | | | |
| c. Sub-activity GH1115-21 | | | Conduct variety registration trials for the diseases-tolerant varieties identified over years and location trials and link farmers with seed enterprises for more access to quality vegetable seeds in Ghana | | | | | | | | | | | |
|  | | |  | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | |
| Name | | | | | Institution | | | Role | | | | | | |
| Jean Baptiste Tignegre | | | | | WorldVeg | | | Plant breeder, activity leader, data analysis | | | | | | |
| Wubetu Legesse | | | | | WorldVeg | | | Plant protection specialist, data collection and data analysis | | | | | | |
| Edoh Kukom | | | | | WorldVeg | | | Agronomist and post-harvest expert, data collection and field management | | | | | | |
| Paul A. Zaato | | | | | WorldVeg | | | Field supervision, data collection, and field management | | | | | | |
| MoFA | | | | | Ministry of Agric. Seed Unit, Tamale | | | Supervision of registration trials and variety registration | | | | | | |
| CSRI/SARI | | | | | SARI, Tamale | | | National research partner for the registration trials; Technologies uptake by NARS’ partner | | | | | | |
|  | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | | Degree | | | Start | End |
| NIL | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| f. Location(s) | | Bonia, Ghana | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| g. Start | | September 2021 | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| h. End | | May 2022 | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | |
| The surveys conducted in Northern Ghana demonstrated that poor access to vegetable seeds in terms of distances and affordability was amongst the top three constraints in the vegetable value chain. In addition, the vegetable varieties validated under the Africa RISING project are not yet registered in Ghana, and the production of certified seeds for dissemination to farmers is not authorized. Variety trials were implemented in the past in Northern Ghana under the UKAID and CORAF/TAV project that involved WorldVeg and local vegetables varieties (onion, pepper, tomato and amaranth, vegetable cowpea). Building on the previous efforts, promising lines of onion, tomato and okra, amaranth, pepper identified in these trials need homologation before dissemination. There is also low access to commercial vegetables distributed by agro-dealers and seed enterprises. | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | |
| 2.1 Initiate the registration of promising onion, tomato, and okra, amaranth lines identified during multi-years and location trials under the Africa RISING project in UER, UWR, and NR | | | | | | | | | | | | | | |
| 2.2 organize linkages between the AR project beneficiaries and local seed enterprises and agrodealers for better vegetable seed deliveries | | | | | | | | | | | | | | |
| 2.3 Enable access to vegetable seeds for AR project beneficiaries by organizing fora with seed enterprises/agro-dealers | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | |
| 3.1 Do varieties proposed for registration perform better than the check varieties in terms of performances for yield, nutrient values, storage duration, and market preferences? | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | |
| This sub-activity will include production, disease assessment, and control, nutritional and postharvest assessments for different crop species, and improved varieties vs. local varieties to test or disseminate tomato, onion, and okra for validation and subsequent registration by the committee in charge of homologation of the crop varieties. The field design will be randomized complete blocks with 4 replicates in Samanko research station. Data will also be collected on dry season trials following the requirements for variety homologation in the country. Agronomic trials (VAT) and variety description, uniformity, and stability tests (DUS) will be required. Other fora will be organized in UER, UER, and NR during the implementation of activity GHA3121-21 to ease linkages with seed enterprises/agro-dealers to fill the gap in the access to improved commercial vegetable varieties seeds that farmers raised. | | | | | | | | | | | | | | |
|  | | | | | | | | | | | |  | | |
| 5. Data to be collected and uploaded | | | | | | | | | | | | Responsibility | | |
| 5.3 and biotic data: resistance to diseases (bacteria blight, Bacteria leaf spot, virus), pests (thrips, mites, fruit borers, etc.) | | | | | | | | | | | | Wubetu Legesse (WorldVeg) | | |
| 5.4 Nutrient content: Vit C, iron, acidity | | | | | | | | | | | | Edoh Kukom (WorldVeg) | | |
|  | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | | End date | |
| 6.1 High performing vegetable varieties with farmers’ preferred traits registered | | | | | | | Africa RISING technical report | | | | | | May 2022 | |
| 6.2 Book chapter and contributions for the WA handbook completed | | | | | | | Final book chapter submitted to chief scientist | | | | | | Mar. 2022 | |
| 6.3 Journal article on onion stability analysis published | | | | | | | Manuscript submitted or published | | | | | | Mar. 2022 | |
| 6.4 3kg of breeders’ seeds of six onion varieties & 50 kg of 10 varieties of tomato, okra produced | | | | | | | Africa RISING technical report | | | | | | May 2022 | |
| 6.5 Extension guide material | | | | | | | Uploaded extension guide material on CGSpace | | | | | | May 2022 | |
|  | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | |
| Domain | Indicators | | | | | Metric & Scale | | | Approach used in data collection | | Before intervention | | | After intervention |
| 7.1 Productivity | Crop productivity | | | | | Fruit yield and fodder yield (Kg/ha) at farm level | | |  | |  | | |  |
| 7.2 Environmental | Diseases scores  Crop postharvest losses | | | | | Number of species & varieties at field/plot level | | |  | |  | | |  |
| 7.3 Economic | N/A | | | | |  | | |  | |  | | |  |
| 7.4 Social | N/A | | | | |  | | |  | |  | | |  |
| 7.5 Human | Nutritional analysis of crops tested for adaptation and postharvest losses | | | | | Nutrient content in tomato & onion under different fertilizer dose application at plot level | | |  | |  | | |  |
|  | | | | | | | | | | | | | | |

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| --- |
| 8. How will scaling be achieved? |
| After the variety homologation is achieved, scaling activities in 2021-2022 will include partnerships with development partners (project beneficiaries, MoFA, SARI, Women farmers’ associations, NGOs, GIZ in UER, UWR, and NR). Knowledge transfer and scaling strategies will include the establishment of research-for-development plots to demonstrate technologies; seed out-growers will be linked to seed enterprises to improve farmers’ access to seeds. Fora are opportunities to formalize collaborations between seed and input partners and project beneficiaries. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| This activity is an integrated approach that involves production and postharvest interventions. It is linked with post-harvest sub-activity GH1116-21 and activities in GH3112-21 and GH3121-21. |
|  |
| 10. Custom indicators |
| * Number of farmers for whom the technology is affordable * Number of farmers for whom the technology is available locally * Extension guide material * Contributions to WA handbook |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  (i) Low access to quality seeds and improved varieties, (ii) high pressure of diseases & pests without effective control methods and uses of banned pesticides, (iii) high postharvest losses by household farmers due to low access to affordable storage facilities, (iv) high rates of malnutrition prevailing for women and infants due to low consumption of vegetables, (iv) low access to land and markets by women, (v) weak linkage to vegetable markets. |
| 11.2 Who is your target audience, e.g. extension agents, farmers, or policymakers?  The targeted audience is farmers, seed enterprises, extension agents, NGOs, farmers’ associations, local community leaders, and policymakers. |

|  |  |  |  |
| --- | --- | --- | --- |
| 12. Budget (US$) | WorldVeg | SARI\* | MoFA\* |
| Personnel | 15,000 | 3,000 | 2,000 |
| Services | 15,000 | 1,000 | 2,000 |
| Supplies | 10,000 |  |  |
| Capital | - |  |  |
| Travel | 2,000 | 3,000 | 4,000 |
| Overhead (18.2%) | 7,644 |  |  |
| Total | 49,644 | 7,000 | 8,000 |

\*WorldVeg is responsible for sub-contracting the partners involved in this sub-activity

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 13. Gantt chart | | | | | | | |
| Year/ month | 2021 | 2022 | | | | | |
| Dec | Jan | Feb | Mar | Apr | May | Jun |
| Field preparation |  |  |  |  |  |  |  |
| Planting nurseries, transplanting |  |  |  |  |  |  |  |
| Data collection |  |  |  |  |  |  |  |
| Data analysis and report writing |  |  |  |  |  |  |  |
| First visit by the variety registration committee |  |  |  |  |  |  |  |
| Second visit by the variety registration committee |  |  |  |  |  |  |  |
| Journal article on onion stability analysis |  |  |  |  |  |  |  |
| Data upload in dataverse |  |  |  |  |  |  |  |
| Production of 3 Kgs of breeder seed |  |  |  |  |  |  |  |
| Extension guide produced |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 1: GH1116-21** | | | | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable, and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | | | | | |
| a. Output 1.1 | | | | Research products for more productive, intensive, diverse, profitable, and resilient crops (cereals, legumes, vegetables), livestock (sheep, goats, cattle, poultry, and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities | | | | | | | | | | | | |
| b. Activity 1.1.1 | | | | Test a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production | | | | | | | | | | | | |
| c. Sub-activity GH1116-21 | | | | Improving yield and post-harvest quality of tomatoes through improved soil and water management practices in the dry season in Northern Ghana- Through determining perception and assessing costs/benefices analysis of postharvest management technologies | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | | | |
| Name | | | Institution | | | | | | | | Role | | | | | |
| Linda Dari | | | UDS | | | | | | | | Activity leader, Postharvest expert | | | | | |
| Bekele Kotu  Felix Badolo | | | IITA  ICRISAT | | | | | | | | Socio-economists | | | | | |
| Edoh Kokum | | | WorldVeg Consultant | | | | | | | | Organization of farmers’ trainings | | | | | |
| Benedict Boyubie | | | IITA | | | | | | | | Monitoring and evaluation/data management | | | | | |
|  | | | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | | | |
| Name | | | Institute | | | | | Degree | | | | | Start | | | End | |
|  | | |  | | | | |  | | | | |  | | |  | |
|  | | | | | | | | | | | | | | | | |
| f. Location(s) | | Duko, Niangua | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| g. Start | | September 2021 | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| h. End | | June 2022 | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | | | |
| The research on the ZECC technology showed that ZECC conducted in Northern Ghana over the past two years was effective in reducing the ambient temperature by 10 to 15OC, which extends tomato and leafy vegetables’ shelf life for two weeks. This sub-activity concerns providing capacity building on the management of postharvest and processing technologies to ease their adoption to participating farmers. In this activity, costs/benefits analysis aims at establishing how affordable the postharvest technologies are to farmers and their perception of the technologies since the sub-activity aimed at establishing how cost-effective the ZECC are. | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | | | |
| 2.1 Determine the perception by AR project beneficiaries on the postharvest technologies and affordability in the UER and NR of Ghana | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | | | |
| 3.1 Can training and practice enable farmers to reduce postharvest losses during storage? | | | | | | | | | | | | | | | | |
| 3.2 To which extent do farmers apply the gained knowledge and skills in vegetable production? | | | | | | | | | | | | | | | | |
| 3.3 What are farmers’ reasons for preference for certain postharvest storage and processing technologies? | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | | | |
| The training sessions on postharvest technologies will be conducted at Africa RISING technologies parks (Niangua and Duko). The training topics will cover practical and theoretical sessions on (i) the causes of vegetable product losses, (ii) how to build zero-energy cooling chambers, (iii) management of ZECC, and (iv) diverse processing techniques. Two sessions are planned in each district (Niangua and Duko) during the dry season. Data will be collected on the number of participants segregated into sex and age, farmers’ preferences for treatments, and the reasons for choosing an option. | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded in Dataverse | | | | | | | | | | | | | Responsibility/Institution | | | |
| Is the data collected part of a multi-year experiment? Yes | | | | | | | | | | | | |  | | | |
| 5.1 Number of participants receiving training, sex and age disaggregated | | | | | | | | | | | | | Tignegre/WorldVeg | | | |
| 5.2 Data on farmers’ preferences for postharvest treatments and the reasons for choosing an option | | | | | | | | | | | | | Legesse/WorldVeg | | | |
|  | | | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | | | | Delivery date | |
| 6.1 Report on the training sessions organized | | | | | | | Summary report included in Africa RISING technical reports | | | | | | | | Mar. 2022 | |
| 6.2 Full project report on farmers’ preferences respective postharvest technologies | | | | | | | Report uploaded on CGSpace | | | | | | | | May 2022 | |
| 6.3 Article on the effect of manure application on tomato qualities | | | | | | | Manuscript completed and submitted | | | | | | | | May 2022 | |
| 6.4 Contribution to the WA Handbook | | | | | | | Submission of final version and approved by chief scientists’ | | | | | | | | Mar. 2022 | |
|  | | | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators and metrics | | | | | | | | | | | | | | | | |
| Domain | Indicator | | | | Metrics/Scale | | | | Approach used | | | Before intervention | | After intervention | | |
| 7.4 Social | Equity,  Collective action | | | | Rating of technologies by group at household level,  Participation in collective action group at household level | | | | Group interview in each district | | |  | |  | | |
|  | | | | | | | | | | | | | | | | |
| 8. How will scaling be achieved? | | | | | | | | | | | | | | | | |
| The training approach is the cascade training or training of trainers provided to extension agents, NGOs, vegetable retailers, and food processors. It is expected that partners attending the training sessions such as project beneficiaries including women associations, MoFA, SARI, GIZ, NGOs, etc.) will ease knowledge transfer to more beneficiaries beyond the project intervention zones. | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 9. How are the activities in this protocol linked to those of others? | | | | | | | | | | | | | | | | |
| This sub-activity is related to sub-activity GH1116-21. | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 10. Custom indicators | | | | | | | | | | | | | | | | |
| 10.1 60 AR project beneficiaries trained on postharvest technologies in NR & UER disaggregated into gender | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 11. Impact-based summary matrix | | | | | | | | | | | | | | | | |
| 11.1 What is the development challenge you are addressing?  Postharvest losses of vegetables were ranked among the top constraints for vegetable production in Mali. Deficiencies of knowledge on adapted and affordable post-harvest technologies are the major challenge faced by vegetable growers in the UER and NR. It is expected that the project beneficiaries’ capacity to implement post-harvest technologies will improve because they will have a better understanding of the procedures that lead to optimized uses of the technologies and extend products shelf life for more consumption and income thus addressing malnutrition and poverty. | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 12. Budget (US$) | | | | | | | | | | | | | | | | |
| Outcome/Output/Activity | | | | | | Sub-activity | | | | Budget line item | | | UDS\* | | | |
| Outcome 2/Output 2/  Activity 2 | | | | | | GH1116-21 | | | | Personnel | | | 2,000 | | | |
| Services | | | 5,000 | | | |
| Supplies | | | 3,000 | | | |
| Travel | | | 2,270 | | | |
| Overhead (18.2%) | | | 2,730 | | | |
| Total | | | 15,000 | | | |

\* WorldVeg will contract UDS and other partners

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 13. Gantt chart | | | | | | |
| Year/ month | 2022 | | | | | |
| Jan | Feb | Mar | Apr | May | Jun |
| Continue improving capacity of project beneficiaries in Duko and Niangua |  |  |  |  |  |  |
| Organize a survey in Niangua and Duko on postharvest technologies |  |  |  |  |  |  |
| Perception studies: participatory selection of post-harvest storage options and processing technologies |  |  |  |  |  |  |
| Report preparation and submission |  |  |  |  |  |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Africa RISING West Africa Activity Protocol – Outcome 1: GH1121-21** | | | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | | | | |
| a. Output 1.1 | | | Research products for more productive, intensive, diverse, profitable and resilient crop (cereals, legumes, and vegetables); livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities | | | | | | | | | | | | |
| b. Activity 1.1.2 | | | Test and disseminate a combination of improved breeds, housing, feeding, health and breeding practices to intensify rearing of livestock (sheep, goat, pig, and poultry) for meat, egg and milk production | | | | | | | | | | | | |
| c. Sub-activity GH1121-21 | | | Evaluate efficient feed utilization through improved feed troughs | | | | | | | | | | | | |
|  | | |  | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | | |
| Name | | | | | Institution | | | Role | | | | | | | |
| Sadat Salifu | | | | | ARI | | | Coordination of sub-activity, data collection on the use of time saved and adoption rate of improved feed trough technology, data analysis, preparation of technical report, and drafting of manuscript | | | | | | | |
| Bekele Kotu | | | | | IITA | | | Contribute to cost and benefit analysis of the feed troughs | | | | | | | |
| Benedict Boyubie | | | | | IITA | | | Design of survey tools and data analysis | | | | | | | |
|  | | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | | Degree | | Start | | End | |
| NIL | | | | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | |
| f. Location(s) | Duko and Tibali (Northern Region), Gia (Upper East Region) | | | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | |
| g. Start | August 2018 | | | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | |
| h. End | March 2022 | | | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | | |
| Data has been collected on the use of improved feed troughs for small ruminants in Duko and Tibali (Northern region) and in Gia (Upper East region) involving thirty farmers (10 farmers in each community) between August 2018 and March 2020. A technical report has been prepared from the preliminary results from data collected in the late dry season (March/April 2019), wet season (September/October 2019), and early dry season (February 2020). The results showed that the improved feed troughs reduced feed waste significantly in all the study communities. The percentages of waste in feeding the animals using the traditional feed troughs were 35%, 22%, and 27% in Duko, Gia, and Tibali, respectively in the late dry season compared to less than 1% with the improved feed troughs during the same season, which implies about 34%, 21% and 26% feed saved in Duko, Gia and Tibali, respectively. Similar trends were observed in the wet and early dry seasons. The time spent feeding the animals was almost halved with the improved feed troughs in the three communities in the late dry season and early dry season. On the time spent feeding the animals, we would need to collect additional information on how the time saved through the improved feed troughs was spent by the participating farmers. A manuscript has been produced for submission to a journal, but it would be important to incorporate the additional information. To promote scaling of the improved feed troughs, two units each were built at 8 Technology Parks in the Northern, Upper East, and Upper West regions. This year we want to collect additional data on labor time saved by farmers using the improved troughs. Also, we want to assess the adoption rate of the technology across the AR communities where the improved trough has been introduced and understand the drivers of adoption as well as impediments to the adoption of the technology. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | | |
| 2.1 The objective of this sub-activity is to produce/publish a journal article on efficient feed utilization through improved feed troughs in Northern Ghana | | | | | | | | | | | | | | | |
| 2.2 To document how time saved through the use of improved feed troughs is spent by the participating farmers. | | | | | | | | | | | | | | | |
| 2.3 To monitor the adoption rate of the feed trough in communities where the technology has been introduced | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | | |
| 3.1 How was the time saved from using improved feed troughs spent by the participating farmers? | | | | | | | | | | | | | | | |
| 3.2 Who are the adopters of the improved feed troughs and what are the drivers of adoption? What are the constraints to the adoption by non-adopters? | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | | |
| The data collected in the late dry season (March/April 2019), wet season (September/October 2019), and early dry season (February 2020) has been analyzed and a manuscript has been drafted based on the results from the data analysis. The manuscript has been submitted to Tropical Animal Health and Production. Additional data will be collected on the use of time saved from the improved feed troughs by the participating farmers. To enhance scaling of the improved feed troughs, 2 units each have been established in 8 Technology Parks in Northern, Upper East, and Upper West regions. A survey will be conducted in these AR communities to monitor the adoption rate, as well as the drivers of adoption and reasons for non-adoption. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded | | | | | | | | | | | | | Responsibility | | |
| 5.1 Data on how time saved is spent by the participating farmers | | | | | | | | | | | | | ARI | | |
| 5.2 Data on adoption rate and drivers/impediments to adoption | | | | | | | | | | | | | ARI | | |
|  | | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | End date | | | |
| 6.2 Data collected time saved as a result of using improved feed trough technology | | | | | | | Data submitted to AR data manager | | | | | Feb. 2022 | | | |
| 6.3 Finalization of the West Africa Handbook in collaboration with the co-authors as a team | | | | | | | Handbook revisions | | | | | Jun. 2022 | | | |
| 6.4 Data collected on adoption rate and drivers of/impediments to adoption | | | | | | | Report of adoption rate study submitted in Semi-annual report | | | | | Mar. 2022 | | | |
| 6.4 Establishment of improved feed troughs in the Technology Parks | | | | | | | Feed troughs establishments in Technology Parks documented in semi-annual reports | | | | | Mar. 2022 | | | |
|  | | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | | |
| Domain | | Indicators | | | | Metric & Scale | | | Approach for data collection | | Before intervention | | | | After intervention |
| Not applicable for a draft manuscript | |  | | | |  | | |  | |  | | | |  |
| Productivity | |  | | | |  | | |  | |  | | | |  |
| Environment | |  | | | |  | | |  | |  | | | |  |
| Economic | |  | | | |  | | |  | |  | | | |  |
| Social | |  | | | |  | | |  | |  | | | |  |
| Human Can also be argued in an economic sense | | | | | | | | | | | | | | | |

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| 8. How will scaling be achieved? |
| Publication of the results from the testing and evaluation of the use of the improved feed troughs in a scientific journal will facilitate dissemination of the technology to a wide scientific community which can promote scaling. Also, the establishment of the improved feed troughs in the Technology Parks will enhance scaling and the model of improved feed troughs with local materials has been shared with Heifer International Tamale and the Livestock Development officers including Research Extension Linkage Committees (RELCs) of Northern Region and Kassena Nankana district. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| This sub-activity is linked to activities on improved crop varieties as the improved feed troughs will be used to feed the crop residues to the animals. This is related to sub-activities such as GH1111-21; GH1112-21 and GH1113-21 (Please see Table 3.1 of workplan) that test and disseminate a combination of climate-smart crop varieties and agronomic practice s to increase and sustain food and feed production |
|  |
| 10. Custom indicators |
| Submitted/published article |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  The development challenge being addressed is improved food security for the smallholder crop and livestock farmers as improved feed troughs will enhance feed use efficiency thereby increasing livestock productivity and consequently food security of the farmers. Less feed waste can also contribute to a profitable livestock enterprise thereby improving household income. |
| 11.2 Who is your target audience e.g., extension agents, farmers, or policymakers?  The smallholder crop and livestock farmers, extension agents and scientific community |

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| --- | --- |
| 12. Budget (US$) | CSIR-ARI |
| Personnel | 6,400 |
| Services | 6,500 |
| Supplies | 3,200 |
| Capital | 0 |
| Travel | 1,295 |
| Overhead | 2,605 |
| Total | 20,000 |

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| --- | --- | --- | --- | --- | --- |
| 13. Gantt chart | | | | | |
| Year/ month | 2021 | | | | 2022 |
| Sep | Oct | Nov | Dec | Jan |
| Data collection on use of time saved from improved feed troughs |  |  |  |  |  |
| Journal paper published in Tropical Animal Production and Health |  |  |  |  |  |
| Data collection on adoption rate of improved feed trough |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 1: GH1122-21** | | | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | | | | |
| a. Output 1.1 | | | Research products for more productive, intensive, diverse, profitable and resilient crop (cereals, legumes, and vegetables); livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities | | | | | | | | | | | | |
| b. Activity 1.1.2 | | | Test and disseminate a combination of improved breeds, housing, feeding, health and breeding practices to intensify rearing of livestock (sheep, goat, pig, and poultry) for meat, egg and milk production | | | | | | | | | | | | |
| c. Sub-activity GH1122-21 | | | Synthesize previous work on feed and health interventions for improved small ruminant production in Northern Ghana | | | | | | | | | | | | |
|  | | |  | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | | |
| Name | | | | | Institution | | | | Role | | | | | | |
| Sadat Salifu | | | | | ARI | | | | Coordination of sub-activity, data analysis, and drafting of manuscripts | | | | | | |
| Solomon Konlan | | | | | ARI | | | | Assistance in data analysis and drafting of manuscript | | | | | | |
|  | | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | | Degree | | Start | | | End |
| NIL | | | | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | |
| f. Location(s) | Botingli, Tibali, Duko (Northern Region); Nyangua, Sambologo, and Gia (Upper East Region), Passe, Zanko, and Guo (Upper West Region) | | | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | |
| g. Start | July 2015 | | | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | |
| h. End | June 2022 | | | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | | |
| An on-farm study on feed-health interventions for improved small ruminant production was conducted in 3 communities each in the Northern, Upper East, and Upper West regions involving 90 farmers to evaluate the effect of the intervention on flock dynamics, animal performance (weight changes), and manure production. The study was conducted between 2014 and 2016 but the data collected has not been analyzed and published. Besides, the data collected will be useful as inputs for the regional review paper on livestock feeding strategies So this sub-activity will be a synthesis of the previous work on feed-health interventions for improved small ruminant production in Northern Ghana. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | | |
| 2.1 The objective of this sub-activity is to synthesize previous work on feed-health interventions for improved small ruminant production in Northern Ghana by publishing it in a journal. The second objective is to contribute to the regional review paper on livestock feeding strategies being led by Africa RISING Ethiopia. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | | |
| 3.1 What are the effects of feed and health package on the flock dynamic and growth performance of sheep and goats in Northern Ghana? | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | | |
| The data collected between 2014 and 2016 on flock dynamic (birth, death, offtake), weight changes, and manure production across all seasons from 90 households in 9 communities will be analyzed and a manuscript will be drafted based on the results from the data analysis. Part of the results will also serve as inputs to the regional review paper on feeding systems and the medicine label brief. This study had 3 treatments (Treatment 1 = health intervention: vaccination against PPR (Peste de petits ruminants, goat plague) and deworming using Ivermectin; Treatment 2= health intervention as above and supplementary feeding of balanced rations) and a control (Treatment 3 = no health and no feed intervention). The 3 treatments explained above were applied at a village level because of the nature of the treatments (in particular the health intervention). The villages in the same region (3) will be considered as a ‘block’ given that they are close enough and matched enough (on agro-ecological and socio-economic profile). The villages were randomly allocated to one of the 3 treatments. Mixed effect models will be used for ANOVA for any response variable with Region effect (2 degrees of freedom), Treatment effect (2 d.f.), and 4 d.f. for the residual, and each treatment has 3 replications/villages. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded | | | | | | | | | | | | | Responsibility | | |
| 5.1 No new data will be collected as existing data will be used | | | | | | | | | | | | |  | | |
|  | | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | End date | | | |
| 6.1 Draft manuscript on the effect of the feed-health intervention on flock dynamic, growth performance, and manure production of small ruminants in Northern Ghana | | | | | | | confirmation by journal of receipt of draft manuscript | | | | | Jan. 2022 | | | |
| 6.2 Published journal article on the effect of feed and health intervention on flock dynamic, growth performance, and manure production of small ruminants in Northern Ghana | | | | | | | Journal | | | | | Mar. 2022 | | | |
| 6.3 Input for the regional review paper on feeding systems | | | | | | | Draft manuscript shared with all co-authors | | | | | Feb. 2022 | | | |
| 6.4 Finalization of the West Africa Handbook in collaboration with the co-authors as a team | | | | | | | Handbook contributions submitted and approved by the chief scientist | | | | | Throughout the whole period | | | |
|  | | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | | |
| Domain | | Indicators | | | | Metric & Scale | | Approach for data collection | | | Before intervention | | | After intervention | |
| Not applicable for a draft manuscript | |  | | | |  | |  | | |  | | |  | |

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| --- |
| 8. How will scaling be achieved? |
| Publication of the results from the effect of feed and health intervention on improved small ruminant production in Northern Ghana in a scientific journal will facilitate dissemination of the technology to a wide scientific community which can promote scaling. The technology has been partially adopted by many farmers in the three study regions though not as an integrated feed and health package. For example, many farmers continued vaccinating their sheep and goats against PPR and used different available feed resources as supplements for their animals instead of formulated ration introduced by the project. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| This sub-activity is linked to Sub-activity GH1112-21 on leaf striping for livestock feeding in maize-based cropping systems. |
|  |
| 10. Custom indicators |
| Two submitted/published articles |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  The development challenge being addressed is improved food security for the smallholder crop and livestock farmers as improved small ruminant production will enhance livestock productivity and consequently food security of the farmers. An increase in flock size will enhance offtake thereby improving household income. |
| 11.2 Who is your target audience, e.g., extension agents, farmers, or policymakers?  The smallholder crop and livestock farmers, extension agents, and scientific community |

|  |  |
| --- | --- |
| 12. Budget (US$) | CSIR-ARI |
| Personnel | 3,000 |
| Services | 1,350 |
| Supplies | 0 |
| Capital | 0 |
| Travel | 0 |
| Overhead | 650 |
| Total | 5,000 |

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| --- | --- | --- | --- | --- | --- |
| 13. Gantt chart | | | | | |
| Year/ Month/ | 2022 | | | | |
| Feb | Mar | Apr | May | Jun |
| Drafting of manuscript and submission to a journal |  |  |  |  |  |
| Revision of manuscript based on reviewers’ comments |  |  |  |  |  |
| Publication in a journal |  |  |  |  |  |
| Input for regional review paper |  |  |  |  |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Africa RISING West Africa Activity Protocol – Outcome 1: GH1111-21** | | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | | | |
| a. Output 1.1 | | | Research products for more productive, intensive, diverse, profitable and resilient crops (cereals, legumes, vegetables), livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities | | | | | | | | | | | |
| b. Activity 1.1.2 | | | Test and disseminate a combination of improved breeds, housing, feeding, health and breeding practices to intensify rearing of livestock (sheep, goat, pig, and poultry) for meat, eggs and milk production | | | | | | | | | | | |
| c. Sub-activity GH1123-21 | | | Assess the effect of feeding maize leaf stripping on digestibility and growth performance of small ruminants and interactions of the technology with child labor (more specifically herding of small ruminants) and school attendance of boys and girls | | | | | | | | | | | |
|  | | |  | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | |
| Name | | | | | Institution | | | | Role | | | | | |
| Addah Weseh | | | | | UDS | | | | Animal scientist, activity leader, development of data collection tools and data analysis | | | | | |
| Joseph Awuni | | | | | UDS | | | | Agricultural economist supporting economic impact analysis | | | | | |
| Joshua Adda | | | | | UDS | | | | Senior Research Assistant, data collections | | | | | |
| Abdul Rahman Nurudeen/Fred Kizito | | | | | IITA | | | | Agronomist supporting agronomic parameters for economic analysis of maize leaf stripping  Systems approach to crop-livestock integration | | | | | |
| Gundula Fischer/ Kipo Jimah | | | | | IITA | | | | Gender specialist, development of gender-sensitive data collection tools, and data analysis | | | | | |
| Bekele Kotu | | | | | IITA | | | | Agricultural economist, economic impact assessment of feeding leaf strippings to sheep and develop tools for data collection and data analysis | | | | | |
| Benedict Ebito Boyubie | | | | | IITA | | | | Develop data collection tools, train the research team on Feed the Future indicators and support in data collection to track output level and FtF indicators  Ensure data upload on Dataverse | | | | | |
|  | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | | Degree | | Start | End | |
| Joshua K. Adda | | | | UDS | | | | | | MPhil (Animal Science) | | Sep. 202 | Jun. 2022 | |
|  | | | | | | | | | | | | | | |
| f. Location(s) | | Northern region (Tingoli, Cheyohi no. 2, Doku and Tibali) | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| g. Start | | October 2018 | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| h. End | | June 2022 | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | |
| This activity which started in 2018 has produced significant data on the *productivity* and *environment* domains of the sustainable intensification assessment framework (SIAF):  Trade-offs and synergies associated with maize leaf stripping within crop-livestock systems in northern Ghana. ***Agricultural Systems 193 (2021) 103206*.** <https://doi.org/10.1016/j.agsy.2021.103206>  Row spacing of annual peanut (*Arachis hypogaea L*.) and the conservation of peanut haulm as hay or silage: effects on nutritive value and growth performance of sheep. ***Ghanaian Journal of Animal Science (2020), 11: 149 -162.***  Effects of ensiling cassava peels on some fermentation characteristics and growth performance of sheep on-farm. ***Ghana Journal Agricultural Science (2021), 55: 107 – 121***. <https://www.ajol.info/index.php/gjas/article/view/202987>  Contributions of livestock production to the education of the boy-child in the Northern Region of Ghana. ***The 15th RUFORUM Annual General Meeting, University of Cape Coast, Ghana. December 2-6, 2019.***   1. Nutritional quality of early- or late-maturing varieties of groundnuts: effects on digestibility and growth performance of sheep fed groundnut haulms. The 15th RUFORUM Annual General Meeting 2019, University of Cape Coast, Ghana. University of Cape Coast (UCC) in Ghana from 2-6 December 2019. 2. Inter-row plant spacing effects on grain and fodder yields, growth performance, digestibility, and manure quality of sheep. *Peanut Science (Accepted for publication, June 2021).*   However, there is a data gap on how the *social, human,* and *economic* SI domains have impacted the beneficiary farmers in the study locations. The proposed activities in this plan of work are a continuation to complete the previous agreement and meant to determine:   1. The economic (profit/loss) impact of stripping maize leaves and feeding them to small ruminants 2. The social/human impact of feeding maize strippings on the opportunities available for the boy child to go to school   In most communities in northern Ghana, feeding small ruminants with nutritious forage during the rainy season can be tedious because farmers cultivate crops around their homestead and there is limited space for grazing. “Cow-boys” therefore have to take small ruminants out of the community to distant locations to graze so that these animals do not destroy cultivated crops in the homestead. This practice accounts in part, for the lower rate of enrolment and high incidence of absenteeism among boys of school-going age in many schools in the Northern and Upper East regions (Addah et al., 2019[[13]](#footnote-14)).  Since 2019, we have been assessing the nutritional value of maize leaf strippings by conducting digestibility, growth, and manure quality trials. Fresh maize leaves are free from any anti-nutritional components and have a higher concentration of crude protein content (8-10%) beyond the minimum requirement of 6% for effective rumen function and a relatively higher dry matter digestibility of 48% (Komarek et al., 2021[[14]](#footnote-15)). Fresh immature maize strippings are also higher in soluble sugar concentrations. Preliminary results from our studies last year show additional benefits of feeding leaf strippings to sheep on the quality of manure and carcass and meat-eating quality.  Data on economic (cost/benefit) and social (school enrolment and absenteeism) analysis of feeding leaf strippings to sheep in the morning so that “cow-boys” can go to school is needed to make meaningful conclusions on the overall benefits of the technology to farmers and other stakeholders in the Agricultural and Educational sectors. This follow-up study will give particular consideration to the application of three (economic, social, and human) of the five (Productivity, Economic, Environment, Human and Social) sustainable intensification assessment framework (SIAF). Substantial data has been collected on the productivity and environment domains of the SIAF since the leaf stripping technology was started in 2018 in UDS. However, work on the other domains (economic, social, and human) has not been completed. | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | |
| 2.1. Evaluate the impact of feeding maize strippings to small ruminants the opportunities available for children to go to school in the morning and graze animals in the afternoon | | | | | | | | | | | | | | |
| 2.2. Determine the economic impact (cost-benefit) analysis of feeding leaf strippings to sheep at the household level | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | |
| 3.1. There is favorable productivity data on feeding maize leaf strippings to sheep but what is the economic benefit of the technology to farmers at the household level? | | | | | | | | | | | | | | |
| 3.2. Will feeding small ruminants with maize leaf stripping in the morning increase the number of boy-child enrollment in schools and reduce school absenteeism? | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | |
| 4.1 Study Area  The study will be continued in 4 Africa RISING intervention communities (Cheyohi No. 2, Duko, Tibali, and Tingoli) in the Northern Region of Ghana.  The study will complete data collection to do a socio-economic analysis of the impact of feeding maize leaf strippings to small ruminants on the opportunities available for the boy-child to go to school and the impact of the technology on household income.  Data analysis will be done at the UDS.  4.2 Cost/benefit analysis  A questionnaire will be used to obtain information on tangible and intangible benefits and costs of the maize leaf stripping technology on farmers at the household level in the four Africa Rising communities. There are two treatments; households practicing the technology and those who are not practicing it. The questionnaire will include:   1. Developing benchmarks for comparing the two treatments 2. Measure social benefits and costs 3. Develop tools for quantifying the effects of the technology on stakeholders and participants 4. Establish a framework to outline the parameters of the analysis 5. Identify costs and benefits so they can be categorized by type and intent 6. Calculate costs and benefits across all stages (agronomic and livestock) of the length of the technology from inception to completion 7. Costs and benefits variables will be categorized into direct, indirect, tangible and intangible, and real components 8. Perform sensitivity analysis 9. Compare cost and benefits using aggregate information 10. Analyse results and make an informed decision and final recommendation   4.3 Socio-economic studies: opportunity to go to school in the morning  A semi-structured questionnaire will be designed and used to obtain data on the socio-economic impact of the maize leaf stripping technology on the opportunity for “shepherd-boys” to go to school in the morning while the small ruminants are offered leaf strippings and then shepherded out of the community to graze upon their return from school in the afternoon.  Secondary data sourced from the school attendance register will give information on school enrolment and absenteeism of the boy child.  Questionnaires will also be administered to parents of the boy-child, the boy-child, teachers, and headteachers.  4.4 Measured parameters and Data Analysis  All the Socioeconomic data will be analyzed with the PROC REG and Categorical data modeling (PROC CATMOOD) procedures of SAS.  For economic analysis, two parameters will be estimated. These are:  Net Present Value (NPV); NPV = ∑ Present Value of Future Benefits – ∑ Present Value of Future Costs  Benefit-cost ratio: = ∑ Present Value of Future Benefits / ∑ Present Value of Future Costs.  Differences in least-square means were declared significant at P ≤ 0.05. | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded | | | | | | | | | | | | | | Responsible |
| 5.1 School enrollment and attendance of the boy-child | | | | | | | | | | | | | | UDS |
| 5.2 Cost-benefit analysis | | | | | | | | | | | | | | UDS/IITA |
| 5.3 School attendance/absenteeism and enrolment data | | | | | | | | | | | | | | UDS |
| 5.4 Proxies for resilience and livelihood enhancement: labor hours saved, the quantity of fodder and number of grazing-free days offered to a farmer as a result of fodder from stripped maize leaves, estimated avoided weight loss from the number of kilometers an animal would walk in search of fodder, % risk reduction from avoided animal thefts while grazing, and avoided disease levels | | | | | | | | | | | | | | IITA/UDS |
|  | | | | | | | | | | | | | |  |
| 6. Milestones | | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | Delivery date | | |
| 6.1 Data on school enrollment and attendance by the boy-child | | | | | | | Project semi-annual report | | | | | Mar. 2022 | | |
| 6.2 Database on economics of and gender-related issues of feeding maize leaf strippings to sheep | | | | | | | Dataverse | | | | | Jul. 2022 | | |
| 6.3 Publication | | | | | | | Manuscript submitted to Ghana Journal for Animal Science | | | | | Aug. 2022 | | |
| 6.4 WA handbook technology contribution | | | | | | | Final submitted and approved by chief scientist | | | | | Mar. 2022 | | |
|  | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | |
| Domain | Indicators | | | | | Metric & Scale | | Approach used in data collection | | | Before intervention | | After intervention | |
| 7.1 Productivity |  | | | | |  | |  | | |  | |  | |
| 7.2 Environment |  | | | | |  | |  | | |  | |  | |
| 7.3 Economic | 1. profit/gain or loss  2. Household income | | | | | Net income/benefit per household per year | | 1. Questionnaire 2. Focus-group discussion | | | No data on impact of the technology in study communities | | Published data available | |
| 7.4 Social | -Gender/Labor roles in feeding maize leaf strippings | | | | | Household | | * Surveys * Focus group discussions | | | The role of boys (or girls) in feeding leaf strippings to livestock not clearly differentiated | | Gender roles in feeding maize leaf strippings delineated | |
| -School enrollment and attendance | | | | | School attendance records/ Ghana Education basic school rankings | | 1. Secondary data of school enrolment records 2. School attendance records at the school and District education office | | | Records on boy child absenteeism from the school attendance register but not synthesized in respect to the technology | | The effect of the leaf stripping technology on school attendance by boys known | |
| 7.5 Human | Human development index at the community level (healthy lifestyles, application of knowledge gained at school) | | | | | Position of the Tolon District on the Annual Basic school rankings | | No. of boy-children attending school in the community | | | 1. Fewer boys attending school 2. High (40-50%) levels of boy-child absenteeism | | 1. More boys attending school   High (10-15%) levels of boy-child absenteeism | |
|  | | | | | | | | | | | | | | |

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| 8. How will scaling be achieved? |
| * The District Ghana Education Service (GES), headteachers, and teachers will be involved and encouraged to monitor school attendance vis-a-vis the leaf stripping project. * The results will be submitted to the District Assembly and District Education office and through RELCs. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| This work is linked to *Sub-activity* GH3122-21 (Assess women and the youth participation in maize and small ruminant value chains in project communities and markets the communities)undertaken by IITA (courtesy Dr. Gundula Fischer) |
|  |
| 10. Custom indicators |
| * 2 Project semi-annual reports * Economic analysis database * Journal publication * Technology brief * Extension guide material * Handbook Chapter |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?   * Household food and income insecurity and natural resource management. * Human resource development (opportunity for boy-child to go school). |
| 11.2 Who is your target audience, e.g., extension agents, farmers, or policymakers?   * Livestock farmers * Boy-child * Ghana Education Service * Teachers/Headteachers |

|  |  |  |
| --- | --- | --- |
| 12. Budget (US$) | IITA | UDS |
| Personnel | 5,000 | 8,200 |
| Services | 0.0 | 3,200 |
| Supplies | 1,500 | 8,500 |
| Capital | 0.0 | 0.0 |
| Travel | 8,000 | 5,500 |
| Overhead | 2,175 | 3,810 |
| Total | 16,675 | 29,210 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 13. Gantt chart | | | | | | | | | |
| Year/ month | 2021 | | | 2022 | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
| Development of data collection tools |  |  |  |  |  |  |  |  |  |
| Training of enumerators/students |  |  |  |  |  |  |  |  |  |
| Data collection |  |  |  |  |  |  |  |  |  |
| Submission of progress report |  |  |  |  |  |  |  |  |  |
| Data processing and analysis |  |  |  |  |  |  |  |  |  |
| M&E for verification |  |  |  |  |  |  |  |  |  |
| Preparation of manuscript and final report |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 1: GH1211-21** | | | | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | | | | | |
| a. Output 1.2 | | | | Integrated management technologies and practices to improve and sustain productivity and ecosystems services of the soil, land, water and vegetation resources are developed and disseminated with farmers and development partners in the intervention communities | | | | | | | | | | | | |
| b. Activity 1.2.1 | | | | Test and disseminate land, soil and integrated land-soil technologies and practices to improve and sustain productivity and ecosystems services at the farm and landscape/watershed | | | | | | | | | | | | |
| c. Sub-activity GH1211-21 | | | | Assessing buffer and adaptive capacity to harness the resilience of different farm types | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | | | |
| Name | | | Institution | | | | Role | | | | | | | | | |
| Mirja Michalscheck | | | WUR | | | | Modeling and farmer interaction | | | | | | | | | |
| Jeroen Groot | | | WUR | | | | Activity coordinator | | | | | | | | | |
| Benedict Boyubie | | | IITA | | | | FtF indicators and data uploading on Dataverse | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | | | |
| Name | | | Institute | | | | | Degree | | Start | | | | End | | |
| Eva Thuijsman | | | WUR | | | | | PhD | | Feb. 2019 | | | | Jul. 2021 | | |
|  | | | | | | | | | | | | | | | | |
| f. Location(s) | Districts in NR, UER, UWR | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| g. Start | September 2019 | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| h. End | September 2023 | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | | | |
| Vulnerability and resilience are two crucial attributes of smallholder farming systems that can be used for analyzing the response to disturbances. We will assess these properties in relation to the buffer and adaptive capacity, which depend on the ‘window of opportunities’ of possible changes in terms of productive, socio-economic, and environmental performance indicators, i.e., the ‘solution space’. The vulnerability of the system can be quantified as the distance of selected performance indicators between original and disturbed systems. The buffer capacity will be derived from the size of the solution space that could be obtained after reconfiguration of farm components (crops, animals, fertilizers, etc.) that were present on the original farm, whereas the assessment of adaptive capacity was derived similarly but after allowing innovation by introducing new components to the farm. These features will be different for the various farm types in the three regions in northern Ghana since they depend on the context (biophysical and socio-economic) and the resources and activities of farms and households. Below we describe the conceptual basis. The activity builds on existing datasets of farm and household structure and farming (from surveys such as GARBES) practices and the proposed and tested Africa RISING technologies (from project scientists).  Conceptual basis  A disturbance can be a pest, a drought, or a product price decline that negatively affects the farming system's performance. The farmer can prepare for or respond to a disturbance by reconfiguring the farm with changes in for instance crop areas, animal numbers, amounts of inputs, selected market channels, or management practices to compensate for the effect of the disturbance. The available options for adjustment of the system with existing components and resources can be considered as the ‘buffer capacity’. When the farmer decides to introduce new crops, animals, inputs, or practices, the required adjustment and reconfiguration (both in the ecological system and in farm management) is expected to be considerably larger than for the buffer capacity and is reflected in the ‘adaptive capacity’. This illustration of the concepts for an agroecosystem demonstrates that besides the ecological (self-) organization, the farmer, his flexibility and skills, and his cognitive and managerial capacities will determine the chosen strategy of adaptation and the final effectiveness of reconfiguration, and thus agroecosystem resilience.  All possible combinations of values of performance indicators constitute the ‘window of opportunities’ or ‘solution space’ for a particular system. The potential of a system (P), resulting from the buffer and adaptive capacity, can be derived from the size of the solution space, which defines the options for adjustment of the system. The solution space is delimited by the Pareto frontier (or Pareto surface when more than two performance criteria are included in the analysis), and for assessment of resilience, we consider only options that perform at least as good as the existing system. The Pareto frontier can be established using multi-objective optimization, and the area (in 2 dimensions), volume (3 dimensions), or hypervolume (>3 dimensions) of the solution space can be calculated, for instance, relative to a given reference point that represents the existing situation.  This is demonstrated in Figure 1, wherein only the portion of the solution space with improvements in two system indicators (productivity and environmental quality in this case) relative to the existing situation after a disturbance is depicted. The buffer capacity (area B in Figure 1a) is estimated as the solution area corresponding to the reconfiguration of links and flows among the components that are already in the system. The adaptive capacity (area A in Figure 1a) is estimated as the expansion of the solution area when new components are introduced in the system. The potential (P) is estimated as the sum of areas A and B.  Macintosh HD:Users:jeroengroot:Dropbox:Artikelen:027 Resilience:Submitted ES:Figure 1.gif  ***Figure 1.***Portions of solution spaces with future options that perform better for two generic objectives, productivity and environmental quality, relative to disturbed states denoted by red symbols. (a) After a disturbance, the system states change following the arrow from point 1 to point 2 (vulnerability v is the distance between points 1 and 2) and move to a more desirable state such as point 3 (resilience r is the distance between points 2 and 3). Area A represents the adaptive capacity and B the buffer capacity of the system after the disturbance. Potential P is calculated are the sum of areas A and B. White symbols denote alternatives for the current system. (b) The potential of a system at consecutive moments in time, with changing attained states (points 1, 3, 5, and 7) and after disturbances (points 2, 4, and 6). | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | | | |
| 2.1 Analyze input-output relations for farm production activities (cropping, animal husbandry, etc.) | | | | | | | | | | | | | | | | |
| 2.2 Quantify potential effects of disturbances on-farm production activities for multiple performance indicators | | | | | | | | | | | | | | | | |
| 2.3 Model farm/household level effects of disturbances to assess vulnerability for different farm types | | | | | | | | | | | | | | | | |
| 2.4 Quantify the buffer and adaptive capacity of farms and households of different types | | | | | | | | | | | | | | | | |
| 2.5 Establish pathways to harness farm and household resilience for different farm types | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | | | |
| 3.1 To what extent are productive, socio-economic, and environmental performance indicators at the farm and household level affected by biophysical and socio-economic disturbances (e.g., drought, price fluctuation) | | | | | | | | | | | | | | | | |
| 3.2 What are the buffer and adaptive capacity of different farm and household types for disturbances in terms of selected productive, socio-economic, and environmental performance indicators? | | | | | | | | | | | | | | | | |
| 3.3 Which efficient pathways for performance improvement can be used to recover after disturbances by different types of farms or households? | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 4. Procedures(survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | | | |
| * FarmDESIGN modeling using existing parameterized farms/ households for three farm types per region * Inventory of production activities that are used on farms or tested by the project (technologies), these production activities (inputs and outputs) are added to the farm models as input data but can also be used to validate the models * Individual discussions and focus group discussions with farmers and experts to assess the feasibility of changes pathways to harness resilience * Surveys, focus group discussions, farming systems modeling, and a serious game | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded to Dataverse | | | | | | | | | | | | | Responsibility/Institute | | | |
| Is the collected data part of a multi-year experiment/ trial? Yes | | | | | | | | | | | | |  | | | |
| 5.1 Parameterized model for various farm types per region | | | | | | | | | | | | | WUR | | | |
|  | | | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | | | |
| Deliverables | | | | | | Means of verification | | | | | | | Delivery date | | | |
| 6.1 Journal article | | | | | | PDF of the submitted paper | | | | | | | 1 March 2022 | | | |
|  | | | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | | | |
| Domain | | Indicators | | | Metric & Scale | | | | Approach for data collection | | | Before intervention | | | | After intervention |
| 7.1. Productivity | | Crop productivity | | | Crop yields (kg/ha/year) under regular and disturbed conditions (at field and farm levels) | | | | Field studies from Africa RISING | | |  | | | |  |
| Animal productivity | | | Animal products (kg/animal/year) under regular and disturbed conditions (at animal and farm levels). | | | | Empirical evidence | | |  | | | |  |
| Input use efficiency | | | Product per input (at the field, herd, and farm levels) | | | | Modeled | | |  | | | |  |
| 7.2. Economic | | Profitability | | | Gross margin of crop and animal operations and operating profit of farm operation (US$) | | | | Calculated/Computed | | |  | | | |  |
| Labor requirement | | | Labor requirements at field, animal, herd, farm, and household levels | | | | Calculated/Computed | | |  | | | |  |
| 7.3 Environment | | Soil chemical quality | | | Carbon and nutrient (N, P, K) budgets, losses to air and soil (at field and farm levels) | | | | Empirical evidence | | |  | | | |  |
| 7.4 Human condition | | Nutrition | | | Nutrient production (kg/year) at field and farm levels | | | | Empirical evidence | | |  | | | |  |
| Food security | | | Food production (kcal/year) at field and farm levels | | | | Empirical evidence | | |  | | | |  |
| Capacity to experiment | | | Willingness to implement a new farm configuration after disturbance | | | | Previous FGDs data | | |  | | | |  |
| 7.5 Social | | Equity | | | Rating of farm configurations per group and agency (leadership roles) | | | | Previous FGDs data | | |  | | | |  |
|  | | | | | | | | | | | | | | | | |
| 8. How will scaling be achieved? | | | | | | | | | | | | | | | | |
| Our assessment builds upon a locally validated but the general pattern of inter- and intra-household diversity. Since our case study households have been selected as representative for farm types of different resource endowments, we expect our findings to be relevant to most other farms of the same type. (We envision testing the transferability of our results by Focus Group Discussions and individual consultations beyond the current case study site to ensure greater validity.) Our findings are meant to guide Africa RISING’s scaling effort, in that we reveal how the resilience of the different farm and farmer types can be improved best by which of the Africa RISING technologies. | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 9. How are the activities in this protocol linked to those of others? | | | | | | | | | | | | | | | | |
| The modeling exercise builds on past and ongoing Africa RISING trial data i.e., data from the technology parks as well as the farmer-led baby- and upscaled trials. The models will be updated, extended, and tested in close collaboration with the Africa RISING-regional coordinators and other project experts in Tamale (NR), Navrongo (UER), and Wa (UWR). | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 10. Custom indicators | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 11. Impact-based summary matrix | | | | | | | | | | | | | | | | |
| 11.1 What is the development challenge you are addressing?  The development challenge being addressed is improving our understanding of how smallholder farming systems respond to disturbances and assessing their vulnerability and resilience. | | | | | | | | | | | | | | | | |
| 11.2 Who is your target audience, e.g., extension agents, farmers, or policymakers?  The target audience is smallholder crop and livestock farmers and extension agents. | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 12. Budget (US$) | | | | | | | | | | | | | | | | |
| Budget line | | | | | | | | | | | WUR (FSE) | | | | WUR (PPS) | |
| Personnel | | | | | | | | | | | 0 | | | | 0 | |
| Services | | | | | | | | | | | 0 | | | | 0 | |
| Supplies | | | | | | | | | | | 0 | | | | 0 | |
| Capital | | | | | | | | | | | 0 | | | | 0 | |
| Travel | | | | | | | | | | | 0 | | | | 0 | |
| Overhead | | | | | | | | | | | 0 | | | | 0 | |
| Total | | | | | | | | | | | 0 | | | | 0 | |
| Grand total | | | | | | | | | | | 0\* | | | | | |
| \*There is no budget assigned for 2021/2022 since the sub-activity was carried over from 2020/2021 and is in the process of finalizing the deliverables | | | | | | | | | | | | | | | | |

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| --- | --- | --- | --- | --- | --- | --- |
| 13. Gantt chart | | | | | | |
| Year/Month | 2021 | | 2022 | | | |
| Nov-21 | Dec | Jan-22 | Feb | Mar | Apr |
| Starting |  |  |  |  |  |  |
| Preparation of farm modeling |  |  |  |  |  |  |
| Fieldwork in 3 regions |  |  |  |  |  |  |
| Revising paper after review |  |  |  |  |  |  |
| Resubmitting to scientific journal |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 1: GH1212-21** | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | |
| a. Output 1.2 | | Research products for more productive, intensive, diverse, profitable and resilient crops (cereals, legumes, vegetables), livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities | | | | | | | | | | |
| b. Activity 1.2.1 | | Test and disseminate land, soil and integrated land-soil technologies and practices to improve and sustain productivity and ecosystems services at the farm and landscape/watershed levels | | | | | | | | | | |
| c. Sub-activity GH1212-21 | | Assess the impact of soil and water conservation interventions in maize-cowpea living mulch system | | | | | | | | | | |
|  | |  | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | |
| Name | | | | Institution | | Role | | | | | | |
| Wilson Agyei Agyare | | | | KNUST, Kumasi | | PI: Soil and water management | | | | | | |
| Fred Kizito | | | | IITA | | Co-PI: Land and water management | | | | | | |
| B. O. Antwi | | | | Soils Research Institute, Kumasi | | Soil and water management support | | | | | | |
|  | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | |
| Name | | | | Institute | | | Degree | | | Start | | End |
| Benjamin Donkor | | | | KNUST | | | MPhil | | | Jan. 2021 | | Jul. 2022 |
|  | | | |  | | | | | | | | |
| f. Location | | | |  | | | | | | | | |
|  | | | |  | | | | | | | | |
| g. Start | | | | July 2017 | | | | | | | | |
|  | | | |  | | | | | | | | |
| h. End | | | | July 2022 | | | | | | | | |
|  |  | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | |
| Justification of sub-activity in relation with previous activities:  This sub-activity started in 2017 and has accumulated a data set that culminated in an MSc. Degree in Kwame Nkrumah University of Science and Technology. The fieldwork and data collection were completed in 2019. The team has conducted data consolidation, analysis, and synthesis for publication. Two manuscripts have been prepared under this sub-activity. One manuscript was submitted to Field Crops Research, the other is yet to be submitted due to internal revisions. Content from the manuscript will contribute to the West Africa Handbook.   1. Soil moisture relations and dynamics within a maize-cowpea living mulch system (Field Crops Research) 2. Implications of seasonal variation of soil moisture and nutrient dynamics in smallholder farming systems: The case for Northern Ghana (Internal Revisions). 3. West Africa Handbook on Land and water management strategies (Submitted to lead Author) 4. Guidebook on Soil and Water Resources Conservation (In Draft format)   This sub-activity will not require new funds for the above deliverables since the development of infographics and release of the farmer guidebook were requested in the 2020/2021 workplan. It is anticipated that the Journal article will be completed in February 2022.  Additional funding will be required to complement field data collected on soil and water conservation through a modeling effort. This will explore scenarios with an APSIM model (Msc. student at KNUST) based on soil and water conservation data collected from the field trials. | | | | | | | | | | | | |
|  | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | |
| 2.1 Determine planting windows for cowpea living mulch in association with maize using APSIM | | | | | | | | | | | | |
| 2.2 Explore scenarios on optimum planting density for cowpea living mulch in association with maize using APSIM as a means to maximize land equivalent ratios and productivity | | | | | | | | | | | | |
|  | | | | | | | | | | | | |
| 3. Research Questions | | | | | | | | | | | | |
| 3.1 What is the best planting window for cowpea living mulch in association with Maize? | | | | | | | | | | | | |
| 3.2 What optimal planting density can provide best results on:   * Utilizing good land equivalent ratios * Maximize crop yield * Provide added environmental benefits in soil and water conservation | | | | | | | | | | | | |
|  | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | |
| All the work will be desk related investigations, modeling with the APSIM model using already collected field data from the last 2 years | | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | Responsibility/Institute | | | |
| Is the collected data part of a multi-year experiment/trial? Yes | | | | | | | | |  | | | |
| Soil loss, soil moisture content, nutrient variations, soil hydraulic properties | | | | | | | | | KNUST/IITA | | | |
|  | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | |
| Deliverables | | | | | Means of verification | | | | | | Dates | |
| 6.1 Farmer guidebook on soil and water | | | | | Approved by chief scientist | | | | | | Jan. 2022 | |
| 6.2 Journal article Field Crops Research | | | | | Published | | | | | | Feb. 2022 | |
| 6.3 Journal article | | | | | Submitted to Journal | | | | | | Feb. 2022 | |
| 6.4 Contribution WA handbook | | | | | Approved by Chief scientist | | | | | | Jul. 2022 | |
| 6.5 Modeling database on land and water management strategies in cereal-legume farming systems | | | | | Dataverse | | | | | | Mar. 2022 | |
| 6.6 Thesis on modeling cereal-legume interactions as soil and water conservation in smallholder farming systems | | | | | Will be Reported in Semi-Annual Report and uploaded on CGspace | | | | | | Jul. 2022 | |
|  | | | | | | | | | | | | |
| 7. Sustainable intensification indicators   | Sustainable intensification indicators | | | | | | | --- | --- | --- | --- | --- | --- | | Domain | Indicator | Metrics and scale of measurement | Methods/Approaches taken including duration | Before intervention | After intervention | | Productivity | Crop productivity | Yield (kg/ha/season) at the field/plot level | Agronomic trials (See GH111-19) for 2017, 2018 and 2019 |  |  | |  |  | | Environmental | Erosion | Soil retention (tons/ha/season) at the plot level | - Field measurements  - Modelling with SWAT and APEX |  |  | | Soil water storage | Seasonal soil moisture storage mm/m | Environmental research (See GH 1212-19) |  |  | | Collective action | Participation in a collective action group (% Household) |  |  |  | |  | % of farmers experimenting (Community level) | Surveys and FGDs |  |  |   \*<https://esoko.com/food-prices-in-ghana-january-2020/> | | | | | | | | | | | | |
|  | | | | | | | | | | | | |
| 8. How will scaling be achieved? | | | | | | | | | | | | |
| Strategic partnerships with both public and private sector entities. The project team is continuing to liaise with MoFA and other local universities including UDS. This will include sharing with them brochures developed for farmer training as well as co-sharing in-field experiences at working group discussions. | | | | | | | | | | | | |
|  | | | | | | | | | | | | |
| 9. How are the activities in this protocol linked to those of others? | | | | | | | | | | | | |
| The activities are related to sub-activity GH1111-19 entitled “Cowpea living mulch effect on weed control, soil properties, and maize yield”. This is an integrative activity in which IITA, and KNUST collaborated on soil and water conservation incorporation within farming systems. The work also closely linked with IITA on cereal-legume cropping systems and mimicked the soil and water conservation approaches that incorporate living mulch in farming systems that have been successfully implemented previously in West Africa. | | | | | | | | | | | | |
|  | | | | | | | | | | | | |
| 10. Custom indicators | | | | | | | | | | | | |
| * Database on land and water management strategies in Cereal-Legume based farming systems * MSc. Thesis | | | | | | | | | | | | |
|  | | | | | | | | | | | | |
| 11. Impact-based summary matrix | | | | | | | | | | | | |
| 11.1 What is the development challenge you are addressing?  Food insecurity and poverty (household level) and NRM (from plot level to landscape level). Through this research, the sub-activity will seek and subsequently share information that preserves the natural resource base through soil conservation thus increasing productivity and contributing to reducing food insecurity and poverty. | | | | | | | | | | | | |
| 11.2 Who is your target audience, e.g. extension agents, farmers, or policymakers?  Smallholder farmers, agricultural extension agents | | | | | | | | | | | | |
|  | | | | | | | | | | | | |
| 12. Budget (US$) | | | | | | | | | | | | |
| Budget line | | | KNUST | | | | | IITA | | | | |
| Personnel | | | 4,000 | | | | |  | | | | |
| Services | | | 3,000 | | | | |  | | | | |
| Supplies | | | 3,000 | | | | |  | | | | |
| Capital | | |  | | | | |  | | | | |
| Travel | | | 3,000 | | | | |  | | | | |
| Overhead (22%) | | | 2,860 | | | | |  | | | | |
| Total | | | 15,860 | | | | | 4,000 | | | | |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| 13. Gantt chart | | | | | | | |
| Year/ month | 2022 | | | | | | |
| Jan | Feb | Mar | Apr | May | Jun | Jul |
| Finalize Farmer Guidebook |  |  |  |  |  |  |  |
| Finalize 1 Journal article |  |  |  |  |  |  |  |
| Finalizing content of Technology Handbook chapter (Includes support to other Handbook chapters) |  |  |  |  |  |  |  |
| Populate APSIM Model for scenario analysis |  |  |  |  |  |  |  |
| Finalize modeling, share MSc. Thesis with Africa RISING |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 1: GH1212-21** | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable and sustainably intensified crop-livestock systems linked to markets | | | | | | |
| a. Output 1.2 | | Integrated management practices and innovations to improve and sustain productivity and ecosystems services of the soil, land, water and vegetation resources are developed and disseminated with farmers and development partners in the intervention communities | | | | |
| b. Activity 1.2.2 | | Test and promote water management technologies and practices to increase water productivity in small-scale crop-livestock farming systems under rainfed and irrigated condition | | | | |
| c. Sub-activity GH1221-21 | | Follow up on the evaluation of the technical and agronomic performance of solar-powered and Bhungroo based small scale irrigation systems in the Upper East Region of Ghana | | | | |
| d. Research team | | | | | | |
| Name | Institution | | Role | | | |
| Minh Thai | IWMI | | Overall project coordination, technical oversight, and Reporting | | | |
| Henry Igbadun | IWMI | | Agricultural Water Management Expert responsible for the evaluation of the technical and agronomic performance of solar-powered and Bhungroo based small scale irrigation systems | | | |
| Olufunke Cofie | IWMI | | Project support and integration | | | |
| Benedict Boyubie | IITA | | Support towards meeting project M&E requirements and FtF indicators while ensuring data upload on Dataverse | | | |
|  | | | | | | |
| e. Student(s) | | | | | | |
| Name | Institute | | | Degree | Start | End |
| NIL |  | | |  |  |  |

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| --- | --- | --- | --- | --- |
| f. Location(s) |  | | | |
|  |  | | | |
| g. Start | September 2019 | | | |
|  |  | | | |
| h. End | May 2022 | | | |
|  | | | | |
| 1. Justification | | | | |
| During the 2019/2020 dry season cultivation period, activity GH1222-20 of the Africa RISING project was initiated to test the technical and agronomic performances of Bhungroo irrigation technology to develop Bhungroo based and solar-powered irrigation business models. The field study involved four irrigation regimes in two communities (Sepaat and Gogoro). The trials were repeated in the 2020/2021 season. The deliverables are being finalized for submission.  Two gaps were identified during the 2020/2021 cropping season. First, the technical efficiency of the Bhungroo solar irrigation system needs to be further assessed and validated. The Bhungroo flow rates and water yields were monitored. However, there is a need to examine the current status of aquifer recharge and recovery characteristics of the Bhungroo and compare it with when the Bhungroo was bored. This is vital in establishing the behavior sustainability of the wells over time. Second, there is a need for water quality and isotope analyses to ascertain the sources and quality of Bhungroo water. These were not carried out in the previous study.  To support community application of the irrigation system, it is important to improve community mobilization, participation, and capacity building in the use of Bhungroo technology. In particular, farmers from the Sepaat community need to be more engaged with the demonstration. The farmers are interested in cultivating other local vegetables beyond the onions and tomatoes that were used as test crops in our trials. We need more community engagement to strengthen capacity around how to operate the system, how to apply the water, frequency, and quantities of application, and overall management of the system linking Bhungroo irrigation technology to the broader context of groundwater resources in the locality. This will involve one season demonstration from October 2021 to March 2022. | | | | |
|  | | | | |
| 2. Objectives | | | | |
| 2.1. Assess the technical efficiency of solar-powered drip irrigation systems towards improved agronomic gains in two communities in two communities | | | | |
| 2.2. Evaluate the differential quality of water in the Bhungroo system compared to adjoining groundwater resource | | | | |
| 2.3. Train farmers in the use of Bhungroo-based solar-powered irrigation system | | | | |
|  | | | | |
| 3. Research questions | | | | |
| 3.1. How effective is Bhungroo and solar-based energy under the different drip irrigation systems? | | | | |
| 3.2. What is the difference in the quality of water in Bhungroo and adjourning groundwater resources and what is the implication for vegetable production? | | | | |
| 3.3. How can we increase farmers’ capacity (knowledge and skills) to ensure they can sustainably use the Bhungroo-based solar-powered irrigation system? | | | | |
|  | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | |
| The field study will be conducted using four irrigation regimes in two communities (Sepaat and Gogoro). Interview and focus group discussion will be carried out among the farmers to assess the interest and perception of the use of Bhungroo by Farmers in the communities. Water quality samples will be taken from the sources and tests will be carried out using standard laboratory procedures. Water samples from the two Bhungroo wells and two community boreholes will be compared using an isotopic tracing test at the Atomic Energy Laboratory, Accra. | | | | |
|  | | | |  |
| 5. Data to be collected and uploaded | | | | Responsibility |
| 5.1 Agronomic data   * Yield (kg/ha)] at each harvest * Water quantity applied and frequency * Performance of the drip system setup * The labor involved * Cost of other inputs such as seed, pesticide, and fertilizers (to be used for economic analysis) | | | | IWMI |
| 5.2 Bhungroo   * Bhungroo flow rates * Bhungroo seasonal supply * Water Quality parameters Fluoride, Chloride, deuterium (2H), and oxygen (18O) | | | | IWMI |
|  | | | | |
| 6. Milestones | | | | |
| Deliverables | | Means of verification | End date | |
| 6.1. Data on technical and agronomic performance of Bhungroo and solar-based drip irrigation system | | Dataverse | Mar. 2022 | |
| 6.2 Report on the performance of Bhungroo and solar-based drip irrigation in the dry season | | Project report to be published in CGSpace submitted | Apr. 2022 | |
| 6.3 Technical guide on the use of Bhungroo | |  | May 2022 | |
| 6.4 Contribution to the WA technology handbook | | Contribution submitted and finalized | Throughout the year | |

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| 7. Sustainable intensification indicators for Onion production in Gorogo | | | | | |
| Domain | Indicators | Metric & Scale | Approach used in data collection | Before intervention | After intervention |
| 7.1 Productivity | Crop productivity | Yield (kg/ha/season) at the field/plot level Farmer rating of yield | Weight measurement at harvested vegetables | 20.9 |  |
|  | Input use efficiency | volume of water applied per irrigation treatment per season at plot level;(m3/ha) | Volume measurement of applied water; | 501.7 |  |
|  | Crop water productivity | Yield of crop / m3 of water applied (kg/m3) | Measurement from the experimental field | 4.2 |  |
|  | Water availability | m3/ha of water saved from irrigation scheduling | Measured and compared against the control | 108.3 |  |
| 7.3 Economic | Economic water productivity | Gross return (GhC)/m3 of water applied | Measurement from the experimental field | 62.9 |  |

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| 8. How will scaling be achieved? |
| This will include:   * Organizing stakeholder meetings with farmers and extension officers on the results of the trials and the preferred water lifting and application methods during the dry season * Sharing research results and engaging with potential scaling partners such as regional offices of the Ministry of Food & Agriculture (MoFA) and GIDA (Ghana Irrigation Development Authority) |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| This sub-activity experiment is linked to other work conducted by IWMI on water use under farmer-led irrigation In addition, it is linked to sub-activities planned by the World Vegetable Centre under GH11.15-21 and GH1116-21 |
|  |
| 10. Custom indicators   * Number of demonstrations established: 02 * Number of farmers trained: 25 * Number of field days organized: 2 * Number of meetings/workshops attended: 02 * Number of project reports produced: 01 technical report on the performance of Bhungroo irrigation technology submitted; Extension technical guide material |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  This sub-activity will address the following major development challenges:   * highly vulnerable to the effects of climate change, while farmers are cultivating in marginal lands with low and erratic and are exposed to more frequent and longer dry spells and floods that threaten food security. * Constraints to smallholders’ access to water management technologies and equipment |
| 11.2 Who is your target audience, e.g. extension agents, farmers, or policymakers?  The most important audience includes small-scale farmers, women, and youth involved in farming. |

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| 12. Budget (US$) | IWMI |
| Personnel | 19,000 |
| Services (including lab) | 16,850 |
| Supplies | 11,500 |
| Capital |  |
| Travel | 8,960 |
| Overhead | 10,890 |
| Total | 67,200 |

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| 13. Gantt chart |  |  |  |  |  |  |  |  |  |  |
| Year/ Month | 2021 | | | 2022 | | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul |
| Farmer engagement |  |  |  |  |  |  |  |  |  |  |
| Field Demonstration and farmer training |  |  |  |  |  |  |  |  |  |  |
| Assessment of water quality |  |  |  |  |  |  |  |  |  |  |
| Preparation of reports and technical guide |  |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 1: GH1411-21** | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable, and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | |
| a. Output 1.4 | | | Tools (including ICT-based) and approaches for disseminating recommendations in relation to the above research products, integrated into capacity development (and used in outcomes 4 and 5) | | | | | | | | | |
| b. Activity 1.4.1 | | | Generate technology extrapolation domains in West Africa. | | | | | | | | | |
| c. Sub-activity GH1411-21 | | | Produce regionally relevant extrapolation domain maps for validated integrated technology packages | | | | | | | | | |
|  | | |  | | | | | | | | | |
| d. Research team | | | | | | | | | | | | |
| Name | | | | | Institution | | | Role | | | | |
| Francis Muthoni | | | | | IITA | | | PI and Spatial analysis | | | | |
| Abdul Rahman Nurudeen | | | | | IITA | | | Cereal agronomy and plant nutrition | | | | |
| Bekele Kotu | | | | | IITA | | | Economic analysis | | | | |
| Fred Kizito | | | | | IITA | | | Land and water management | | | | |
| Benedict Boyubie | | | | | IITA | | | Field data collection and upload data on Dataverse | | | | |
| Winifred Ayinpogbilla Atiah | | | | | KNUST | | | Agro-meteorology | | | | |
| Leonard Amekudzi | | | | | KNUST | | | Agro-meteorology | | | | |
| Lexy Ratering | | | | | VanderSat | | | Soil moisture dashboard | | | | |
| Jerry quantson, Evelyn Rose Debrah | | | | | Ghana Agricultural Insurance pool (GAIP) | | | Weather Index insurance | | | | |
|  | | | | |  | | |  | | | | |
|  | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | |
| Name | | | | Institute | | | | | Degree | | Start | End |
| #2 Vacancies | | | | KNUST | | | | | MSc | | 2021 | 2022 |
|  |  | | | | | | | | | | | |
| f. Location(s) | Northern (Tingoli, Cheyohi no. 2, Doku, Tibali), Upper East (Samboligo, Nyangua, Gia, Bonia), Upper West (Zanko, Guo, Goli, Goriyiri) regions | | | | | | | | | | | |
|  |  | | | | | | | | | | | |
| g. Start | June 2019 | | | | | | | | | | | |
|  |  | | | | | | | | | | | |
| h. End | July 2022 | | | | | | | | | | | |
|  |  | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | |
| Sustainable intensification technologies are suited to specific biophysical and socio-economic contexts. Technologies validated at a location should be suitable for scaling to other places with relatively similar biophysical and socio-economic conditions. Identification of areas with relatively similar conditions or outcomes to those observed in the technology trial sites is one of the essential components of successful scaling out. Biophysical conditions and crop yields obtained from trial sites with good performance of technological packages will be utilized as a reference for mapping other potentially suitable sites in the West Africa region. Maps on technology recommendation domains will guide development partners and extension agencies to scale-out technologies to relevant contexts, thus reducing the risk of failure for Africa RISING validated technologies. Since 2016, on-farm trials were conducted to validate bundles of technologies. The trials identified the best-bet combinations of groundnut spacing and fertilizer rates that produce the highest yields in Northern Ghana. During the last cropping season (2020-2021) maps for the onset and cessation of rain and the length of growing period (LGP) for the last 40 years were generated from satellite rainfall estimates [[15]](#footnote-16). These maps were validated with gauge and farmer knowledge. Moreover, the trends and inter-annual variability of the onset and cessation of the rainfall seasons were generated. Furthermore, the forecasting methods and the adaptation methods applied by farmers were evaluated. A manuscript was submitted and is currently undergoing revisions based on peer reviewers' report1. Results showed that the agreement of the three satellite-derived rainfall indices (onset, cessation, and length of the rain season) with the gauge data varied over space and time. Substantial biases were noted that may affect the reliability of agro-advisories generated from daily satellite rainfall estimates. Therefore, the study recommended bias correction of the CHIRPS-v2 satellite daily rainfall to reduce the biases when deriving the rainfall indices (onset, cessation, and length of the rain season). Bias correction of satellite rainfall data is effective in removing systematic bias in the time series that remains after global bias correction[[16]](#footnote-17),[[17]](#footnote-18). The study will evaluate the effectiveness of quantile mapping and Bayesian bias correction algorithms. The bias-corrected daily CHIRPS-v2 rainfall will be applied to derive the three rainfall seasonality indices (onset, cessation of rains, and the length of the rainy season). The agreement of the three rainfall seasonality indices derived from bias-corrected CHIRPS-v2 with those derived from the gauge will determine the effectiveness of bias correction.  The onset, end, and length of the rain season determine the crop calendar activities such as the timing of planting and the choice of crop varieties for planting (early, medium, or late maturity). Information of trends of the onset can help farmers improve their decision-making about the selection of crop types and varieties. Informed farmers can also reduce the risks and costs related to the re-sowing or re-planting process. The analysis during the last cropping season identified the trends of the rainfall onset, cessation, and LGP in northern Ghana. The information generated last cropping season on trends of rainfall seasonality in northern Ghana will be repackaged into an extension bulletin that extension agents and farmers can understand easily. The extension bulletin will illustrate localized agro-advisory recommendations regarding the timing of seasonal calendar activities and the suitability of crop varieties.  Agriculture in Africa is predominantly rainfed. However, rainfall in northern Ghana is characterized by high inter and intra-seasonal variability that induces great uncertainty and risk when making farming decisions. Rainfall forecasts before the start of the season are key early warning systems that guide the implementation of coping strategies. Access to rainfall forecasts before the onset of the season can potentially assist farmers to adapt and make appropriate farming decisions on time. Early action based on seasonal forecast of droughts achieves potential economic savings of up to 70%. However, our study during the 2020/2021 cropping season revealed that over 70% of the farmers in northern Ghana rely on traditional methods of forecasting the onset of rains compared to scientific data1. Traditional methods are increasingly unreliable due to the prevalent effects of climate change and variability[[18]](#footnote-19). Seasonal forecasts are a critical mechanism to cope with food security risks and water management. The study highlighted the need for promoting the use of scientific forecasting in an area with a limited gauge network. Therefore, satellite-based rainfall forecasts could complement the scarce gauge network. Nyadzi et al. (2018[[19]](#footnote-20)) demonstrated that the European Centre for Medium-Range Weather Forecasts (ECMWF-S4)has the potential to provide actionable hydro-climatic information that may support farmers’ decisions in northern Ghana at a lead time of 0-2 months. They reported that the forecast bias, correlation, and skills for ECMWF-S4 rainfall vary with season and location but generally are unsystematic and relatively constant with forecast lead time. This made it possible to meet farmers’ needs at their most preferred lead-time of one month before the onset of the growing season. Recently, ECMWF-S4 was upgraded with ECMWF-S5[[20]](#footnote-21), but the performance of the new dataset has not been evaluated in northern Ghana. The proposed study will evaluate the skill the ECMWF-S5 rainfall forecasts at different lead times to determine its ability to guide timing of early action to climate risk such as the timely adjustment of seasonal calendar activities in small-scale farming systems in northern Ghana.  Rainfall is the main source of soil moisture in smallholder farming systems in northern Ghana. However, only a fraction of rainfall is available to plants due to substantial soil moisture (SM) losses through runoff, evaporation, and canopy interceptions. SM is a more direct measure of plant-available water. However, in-situ measurements of SM over large areas are costly and cumbersome. SM derived from earth-observing satellites can complement ground measurements. The existing satellite-derived soil moisture products have coarse spatial resolution ranging from 9 – 25 Km, relatively short time series, and are predominantly from passive sensors that are attenuated by cloud and canopy cover[[21]](#footnote-22). To address the above limitations, VanderSat released a commercial near real-time downscaled SM product from active satellite sensors that is not affected by cloud cover[[22]](#footnote-23). VanderSat’s SM product is derived by downscaling products retrieved from a constellation of NASA, ESA, and JAXA satellites. The VanderSat SM product has over 18-year daily time series imagery at unprecedentedly high spatial resolution (100 m). The effectiveness of the VanderSat SM product on monitoring drought over the growing season has been demonstrated in several drought index insurance schemes in Africa (https://vandersat.com/industries/insurance-banking/drought-index-insurance). The proposed activity is a collaborative activity between excellence in Agronomy 2030 (EiA2030) project’s use-case in northern Ghana and Africa RISING to develop a spatially explicit dashboard showing the daily progression of soil moisture over the growing season. Information derived from the dashboard will inform the magnitude of agricultural drought to inform decision making such as the timing of cropping calendar activities and act as a basis for triggering payments of crop insurance. The dashboard will identify areas experiencing deficit, normal, or excess soil moisture daily. Moreover, a pilot will be tested for identifying soil moisture thresholds that can trigger crop insurance payments for farmers' insurance by a GAIP. | | | | | | | | | | | | |
|  | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | |
| 2.1 Bias correction of daily satellite-based rainfall estimates for better capturing of seasonality metrics in Ghana | | | | | | | | | | | | |
| 2.2 Determine if bias correction of daily satellite-based rainfall estimates improves identification of the onset, cessation, and length of the rainy season in northern Ghana | | | | | | | | | | | | |
| 2.3 Validate the ECMWF-S5 satellite-based seasonal rainfall forecasts for food security early warning systems and crop insurance in northern Ghana | | | | | | | | | | | | |
| 2.4 Develop spatially-explicit dashboard for near-real-time monitoring of soil moisture anomalies in northern Ghana | | | | | | | | | | | | |
|  | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | |
| 3.1 Does bias correction of daily CHIRPS-v2 data improve satellite-based estimates of rainfall in northern Ghana? | | | | | | | | | | | | |
| 3.2 Which is the most effective bias correction algorithm for matching daily CHIRPS-v2 rainfall with gauge data? | | | | | | | | | | | | |
| 3.3 Does bias correction of daily CHIRPS-v2 rainfall estimates improve detection of the onset, cessation, and the length of the rainy season from daily CHIRPS-v2 rainfall estimates in Northern Ghana compared to the gauge data? | | | | | | | | | | | | |
| 3.4 Does satellite-based ECMWF-S5 seasonal rainfall forecasts agree with gauge observation? | | | | | | | | | | | | |
| 3.5 Can a near-real-time dashboard representing high resolution (daily 100m) soil moisture anomalies effectively guide agro-advisories over the cropping calendar? | | | | | | | | | | | | |
|  | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | |
| Daily rainfall data from 6 rain-gauges maintained by Ghana meteorological agency (GMet) will be used for bias correction. The daily satellite rainfall estimates will be downloaded from the Climate Hazards Group Infrared Precipitation with Stations (CHIRPS-v2) database. | | | | | | | | | | | | |
|  | | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | Responsibility/Institute | | |
| Is the collected data part of a multi-year experiment/trial? No | | | | | | | | | |  | | |
| 5.1 Daily CHIRPS-v2 gridded satellite-based rainfall | | | | | | | | | | IITA | | |
| 5.2 Satellite based soil moisture layers | | | | | | | | | | VanderSat | | |
| 5.3 Satellite-based rainfall forecasts | | | | | | | | | | IITA/KNUST | | |
| 5.4 Weather station data (rainfall) | | | | | | | | | | KNUST | | |
|  | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | |
| Deliverables | | | | | | Means of verification | | | | | Delivery date | |
| 6.1 Database of bias-corrected daily CHIRPS-v2 satellite-based rainfall data | | | | | | Database | | | | | Apr. 2022 | |
| 6.2 Maps of the trend and variability onset, cessation, and length of rain season from bias-corrected CHIRPS-v2 data | | | | | | Database and maps | | | | | Apr. 2022 | |
| 6.3 Manuscript on trends of onset, cessation, and length of rainy season revised and re-submitted | | | | | | Journal article published | | | | | Apr. 2022 | |
| 6.4 ECMWF-S5 seasonal rainfall forecast data validated in northern Ghana | | | | | | #1 Manuscript submitted | | | | | Apr. 2022 | |
| 6.5 Soil moisture dashboard | | | | | | Near-real time dashboard for soil moisture | | | | | Apr. 2022 | |
|  | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | |
| Domain | | Indicator | | | | | Metrics | | | | | |
| 7.1 Productivity | |  | | | | |  | | | | | |
| 7.2 Economic | |  | | | | |  | | | | | |
| 7.3 Environmental | |  | | | | |  | | | | | |
| 7.4 Human | |  | | | | |  | | | | | |
| 7.5 Social | |  | | | | |  | | | | | |

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| 8. How will scaling be achieved? |
| Maps generated from this activity will be a decision support tool to guide better scaling out of validated technologies. Maps will be shared with extension and development agencies to guide evidence-based scaling out of technology packages. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| This activity is linked to sub-activity GH1111-20: Cowpea living mulch effect on weed control, soil properties, and maize yield. |
|  |
| 10. Custom indicators: |
| 10.1 Technical reports  10.2 Geodatabase of bias collected daily satellite-based gridded rainfall layers.  10.3 Journal publication |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  Food insecurity and natural resource management |
| 11.2 Who is your target audience?  The extension and development agents involved in scaling-out of technologies. |

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| 12. Budget (US$) | | | |
| Budget Line | IITA | KNUST | TOTAL |
| Personnel | 2,0001 | 10,0002 | 12,000 |
| Services | 2,0003 | 1,0354 | 3,035 |
| Supplies | 3,0005 |  | 3,000 |
| Capital |  |  |  |
| Travel | 6,5126 |  | 6512 |
| Overhead |  |  |  |
| Total | 13,512 | 11,035 | 24,547 |
| 1Costs of personnel time for design of interactive dashboard for soil moisture @$2,000 x 1 month = $2,000  2Costs of personnel time for data curation, analysis, writeup and students’ co-supervision @$2,500 x 4 month = $10,000  3Costs of open-source publication @$2,000  4Costs of MSc research costs at KNUST @$86.2 x 6 months x 2 students= $1,035  5 Supplies includecosts of software licenses: (ArcGIS renewal 50% =$500, R cloud subscription $500) part cost of soil moisture daily satellite imagery @ 2,000 = $3,000  6Costs of travel to Ghana for field validation, supervise MSc research and farmer’s engagements | | | |

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| 13. Gantt chart | | | | | | | | | | | | |
| Activity/Deliverable | 2021 | | | | | | | | 2022 | | | |
| May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
| Bias correction of daily CHIRPS & derive onset, cessation, LGP | | | | | | | | | | | | |
| Gathering and processing Remote sensing and gauge data |  |  |  |  |  |  |  |  |  |  |  |  |
| Bias correction of CHIRPS-v2 data |  |  |  |  |  |  |  |  |  |  |  |  |
| Computing onset, cessation, and LGP from bias-corrected CHIRPS-v2 data and validated with gauge data |  |  |  |  |  |  |  |  |  |  |  |  |
| Revising & resubmission of manuscript on trends and variability of onset, cessation, and LGP |  |  |  |  |  |  |  |  |  |  |  |  |
| Validation of ECWF-S5 rainfall forecasts | | | | | | | | | | | | |
| Downloading and processing ECWF-S5 imagery and gauge data |  |  |  |  |  |  |  |  |  |  |  |  |
| Validation of ECWF-S5 with gauge data |  |  |  |  |  |  |  |  |  |  |  |  |
| Manuscript write-up & submission |  |  |  |  |  |  |  |  |  |  |  |  |
| Design soil moisture dashboard | | | | | | | | | | | | |
| Preliminary discussions with partners (EiA2030, GAIP, VanderSat) on parameters and thresholds for soil moisture monitoring |  |  |  |  |  |  |  |  |  |  |  |  |
| Acquisition and processing VanderSat soil moisture imagery |  |  |  |  |  |  |  |  |  |  |  |  |
| Design of interactive dashboard |  |  |  |  |  |  |  |  |  |  |  |  |
| Generate user manual for soil moisture dashboard |  |  |  |  |  |  |  |  |  |  |  |  |
| Communication and dissemination |  |  |  |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 1: GH1412-21** | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | |
| a. Output 1.1 | | | Tools (including ICT-based) and approaches for disseminating recommendations in relation to the above research products, integrated into capacity development (and used in outcomes 4 and 5) | | | | | | | | | |
| b. Activity 1.4.1 | | | Generate technology extrapolation domains in West Africa | | | | | | | | | |
| c. Sub-activity GH1412-21 | | | Identify the sustainable agricultural intensification technologies and household characteristics that determine the maize grain yields at the different technology extrapolation domains | | | | | | | | | |
|  | | |  | | | | | | | | | |
| d. Research team | | | | | | | | | | | | |
| Name | | | | | Institution | | | Role | | | | |
| Francis Muthoni | | | | | IITA | | | Spatial analysis and activity leader | | | | |
| Bekele Kotu | | | | | IITA | | | Economic analysis | | | | |
| Shaibu Mellon Bedi | | | | | Center for Development Research, ZEF | | | Economic analysis | | | | |
| Jeroen Groot | | | | | WUR | | | Modelling | | | | |
|  | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | |
| Name | | | | Institute | | | | | Degree | | Start | End |
| NIL | | | |  | | | | |  | |  |  |
|  |  | | | | | | | | | | | |
| f. Location(s) | Northern (Tingoli, Cheyohi no. 2, Doku, Tibali), Upper East (Samboligo, Nyangua, Gia, Bonia), Upper West (Zanko, Guo, Goli, Goriyiri) regions | | | | | | | | | | | |
|  |  | | | | | | | | | | | |
| g. Start | May 2020 | | | | | | | | | | | |
|  |  | | | | | | | | | | | |
| h. End | Sept 2022 | | | | | | | | | | | |
|  |  | | | | | | | | | | | |
|  | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | |
| Sustainable intensification technologies (SAI) are suited to specific biophysical and socio-economic contexts. The low adoption of SAI technologies in smallholder farming systems in Ghana is partly due to poor spatial targeting. Maps of Technology Extrapolation Domains (TEDs), that encompass non-contiguous zones with relatively similar agricultural and investment potential can improve the targeting of SAI technologies. Crop yields or responses to management practices are relatively similar within a specific TED. TEDs are utilized to target technologies to their proper context, thus reducing the probability of failure. Information on factors that determine variations in maize yields at different TEDs in Ghana is lacking. Several TEDs have been mapped in Ghana from gridded biophysical layers. However, agricultural investments and policies are formulated primarily based on administration units. There is a knowledge gap on which bundles of SAI technologies are suitable for specific TEDs. Moreover, household characteristics such as resource endowments, level of education influence the adoption of SAI technologies. Management practices and socio-economic factors that drive the variability of maize yields at fine-scale TEDs in Northern Ghana will be identified. During the last cropping season, a machine learning model based on the conditional inference tree (CIT)[[23]](#footnote-24) framework was utilized to analyze data in the GARBES database to identify the determinants of maize yields at different TEDs.  The analysis is 65% complete as cleaning of the input GARBES data took longer than expected. The machine learning models were computationally intensive and took longer to converge, thus delaying the calibration. A machine learning model based on the Conditional Inference Tree (CIT)[[24]](#footnote-25) framework was applied to detect the significant variables that influence the variability in maize grain yields. The grain yield was the response, while the predictors were the farmer characteristics, dummy variable representing technologies applied, and farm characteristics (Table 3). A tree dendrogram was produced to indicate the split criterion, mean yield, associated p-values, error (SEE), and the number of samples in intermediate and terminal nodes. The predictor variables that were split higher up on the CIT tree contributed the highest variance in the yield. The higher the node was split along the tree, the higher the variance is explained in the model. The models were evaluated using the coefficient of determination (R2) and root mean square of error (RMSE). The variable importance was measured as the mean decrease in accuracy if the predictor were removed from the CIT models of maize yields. A draft manuscript is in preparation. During the current cropping season, the remaining analysis and write-up of the manuscript will be finalized. A random forest model will also be applied in the analysis as they have been reported to be more robust compared to single decision trees like the CIT that was earlier applied. The information generated from this study will help in targeting SAI technologies in a proper context. | | | | | | | | | | | | |
|  | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | |
| 2.1 To compare the performance of two machine learning models conditional inference trees (CIT) and random forest) in predicting maize yield in northern Ghana | | | | | | | | | | | | |
| 2.2 To identify the most important sustainable agriculture intensification (SAI) practices and socio-economic factors that explain the variance of maize yields at different TEDs in Ghana | | | | | | | | | | | | |
|  | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | |
| 3.1 What are the SAI practices and socio-economic factors that significantly explain the variation of maize yields at different TEDs in Ghana? | | | | | | | | | | | | |
|  | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | |
| 4.1 The previous analysis of the GARBES data using a Conditional Inference Tree (CIT-Tree) algorithm will be extended to also include a random forest model to extract knowledge on which bundles of SAI technologies and household characteristics significantly drive variability in maize grain yields at different TEDs in Ghana. | | | | | | | | | | | | |
|  | | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | Responsibility/Institute | | |
| Is the collected data part of a multi-year experiment/trial? No | | | | | | | | | |  | | |
| No data collection | | | | | | | | | |  | | |
|  | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | |
| Deliverables | | | | | | Means of verification | | | | | Delivery date | |
| 6.1 Technology extrapolation domains | | | | | | Maps in Dataverse | | | | | Mar. 2022 | |
| 6.2 Manuscript on determinants of maize yields at different TEDs | | | | | | Manuscript submitted to journal | | | | | Mar. 2022 | |
|  | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | |
| Domain | | Indicator | | | | | Metrics | | | | | |
| 7.1 Productivity | |  | | | | |  | | | | | |
| 7.2 Economic | |  | | | | |  | | | | | |
| 7.3 Environmental | |  | | | | |  | | | | | |
| 7.4 Human | |  | | | | |  | | | | | |
| 7.5 Social | |  | | | | |  | | | | | |
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| 8. How will scaling be achieved? |
| Maps generated from this activity will identify which identify spatial typologies where specific sustainable intensification technologies are to target while also considering the socio-economic context of farmers. |
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| 9. How are the activities in this protocol linked to those of others? |
| This activity is linked to sub-activity GH4112-20: Evaluate the impact of sustainable intensification practices on household welfare, poverty, perceived shock, the environment, and food and nutrition security in northern Ghana. |
|  |
| 10. Custom indicators: |
| 10.1 Technical report  10.2 Journal article submitted for publication |
|  |
| **11. Impact-based summary matrix** |
| 11.1 What is the development challenge you are addressing?  Food insecurity and natural resource management |
| 11.2 Who is your target audience?  The extension and development agents involved in scaling-out of technologies. |

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| 12. Budget (US$) | |
| Budget Line | IITA |
| Personnel | 5,0001 |
| Services | 1,0002 |
| Supplies |  |
| Capital |  |
| Travel | 1,0003 |
| Overhead |  |
| Total | 7,000 |
| 1Cost for consultancy to fit a machine learning model and refine the agroclimatic zones  2Cost for open access publication  3Cost for participating in #1 International conference | |

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| 13. Gantt chart | | | | | | | | | | | |
| Year/ Month | 2021 | | | | | | | | 2022 | | |
| May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar |
| GARBES data Cleaning |  |  |  |  |  |  |  |  |  |  |  |
| Generate fine ACZ as TEDs |  |  |  |  |  |  |  |  |  |  |  |
| Analysis with machine learning algorithm |  |  |  |  |  |  |  |  |  |  |  |
| Manuscript write-up |  |  |  |  |  |  |  |  |  |  |  |
| Communication & dissemination |  |  |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 2: GH2121-21** | | | | | | | |
| Outcome 2: More farmers and farm families in the intervention communities are adopting technologies and practices to improve nutrition, food and feed safety, post-harvest handling and value addition | | | | | | | |
| a. Output 2.1 | | | Improved technologies, practices and habits to increase production and consumption of diverse and more nutritious food by farm families, especially by women and children are developed | | | | |
| b. Activity 2.1.2 | | | Train farm families, especially women, to produce and consume diverse and more nutritious food | | | | |
| c. Sub-activity GH2121-21 | | | Container gardening training combined with nutrition education for increased vegetable consumption | | | | |
|  | | |  | |  | | |
| d. Research team | | | | | | | |
| Name | | | Institution | | Role | | |
| Mahama Saaka | | | UDS-Dept. Nutritional Sciences | | Sub-activity leader coordinating project activities | | |
| Clement Kubuga | | | UDS-Dept. Nutritional Sciences | | Training and supervision of farmer groups on the use of container vegetable gardening | | |
| Fauzia Sadick | | | Women in Agric Development (WIAD) | | Mobilization of community interest groups (e.g. women’s groups) | | |
| Benedict Ebito Boyubie | | | IITA | | Development of data collection tools, training of the research team on Feed the Future indicators and supporting data collection to track output level and Feed the future indicators,  Ensuring data upload on DataVerse | | |
|  | | | | | | | |
| e. Student(s) | | | | | | | |
| Name | Institute | | | Degree | | Start | End |
| NIL |  | | |  | |  |  |
|  | | | | | | | |
| f. Location(s) | | 25 communities in 5 districts (Savelugu, Tolon, Wa West, Nadowli, and Kassena-Nankana) of northern Ghana (This expands beyond the 12 Africa RISING communities) | | | | | |
|  | |  | | | | | |
| g. Start | | July 2018 | | | | | |
|  | |  | | | | | |
| h. End | | June 2022 | | | | | |
|  | | | | | | | |
| 1. Justification | | | | | | | |
| This is a continued sub-activity that was initiated in July 2018 in response to reports that farmers were not patronizing a vitamin A fortified variety of tomatoes that were being promoted by WorldVeg in the Upper East. Due to low patronage, the production of this tomato variety was discontinued, the farmers complained the variety was not attractive to consumers and therefore had no market value. It became obvious that the farmers were more interested in selling than consuming the vegetables they produce. Consequently, nutrition education on the nutritional value and preparation of vegetables was broadcasted through the radio to raise awareness of the nutritional value of vegetables generally. The findings of formative research showed that the availability and/or own production of fruits and vegetables was the main factor that makes it easier for households to consume fruit and vegetables**.** The program implication of this finding was that the promotion of container home gardens will contribute to improving the availability of vitamin-rich fruits and vegetables to households. This warranted a modification of this sub-activity in September 2019 when the concept of container gardening technology was introduced to allow households to produce their own vegetables even in the dry season. Model vegetable container gardens have been set up in 18 communities. However, due to restrictions around COVID-19, engagements with communities in a sustainable manner were disrupted for most of 2020. This notwithstanding, there is steady progress towards the finalization of the targeted deliverables, but some further work needs to be carried out during a six-month extension to firm up conclusions from ongoing behavior change interventions. We are therefore taking advantage of the extension period of the Africa RISING project to improve on the intervention fidelity and to consolidate/enhance the external validity of findings from the ongoing intervention. The extension of the implementation period will also make it possible to reach out to more households which will permit the adequate collection of data to evaluate the impact of the program.  In most households of Northern Ghana, there is an inadequate intake of micro-nutrients partly due to lack of access to a variety of foods, and intake of animal source foods is low. The quality of a child’s diet is a key determinant of optimal growth, development, and health. Poor nutrition not only retards growth and development but also increases children’s risk of developing chronic diseases such as obesity, increased cholesterol levels, and hypertension later in life (Berenson *et al*., 1998[[25]](#footnote-26); Schneider *et al*., 2007[[26]](#footnote-27); Skinner *et al.[[27]](#footnote-28)*, 2004).  Micronutrient deficiencies may be addressed by increasing the availability and access to, and ultimately consumption of foods that are rich sources of micronutrients. A food-based approach that could help reduce micronutrient deficiencies by providing nutrient-rich foods is container home gardening (Shisanya S.O., Hendriks S.H., 2011[[28]](#footnote-29); Berti P.R., Krasavec J., Fitzgerald S., 2004[[29]](#footnote-30); Holmer R.J., 2011[[30]](#footnote-31); Keatinge J.D.H. *et al*., 2011[[31]](#footnote-32)). It is further argued that vegetable gardening enables women to have greater authority over the quality of the family diet (Ruel, M.T., Levin C.E., 2001[[32]](#footnote-33)). In addition, the potential use of household wastewater for irrigation and household organic wastes for compost provides opportunities to make efficient use of limited resources and close broken nutrient cycles and this is of benefit to the environment and can represent a sustainable system.  However, poor diets and inadequate food intake are not always the result of a lack of food or money to buy food. People must have some knowledge of nutrition: the most important information is what kinds of food to eat and how to prepare the food in the right quantities and mixes and in a way that is safe and clean for children's healthy growth and development. Therefore, concurrent nutrition education and container home vegetable production are key elements of this sub-activity.  For poor households, vegetables and fruits are often the only sources of micronutrients in the family diet. Homestead production of fruits and vegetables provides the household with direct access to important nutrients that may not be readily available or within their economic reach.  A sustainable means of producing basic essential food such as vegetables is a requirement for preventing micronutrient deficiencies. A container home garden can supply a family with substantial quantities of a variety of foods all year round and a source of family income. Container home gardening, therefore, has economic and nutritional merit but which most households are not taking advantage of due to some constraints including the lack of land and water availability.  Therefore, this study seeks to evaluate whether home gardening in containers would be a good means to improve household food and nutrition security. The intervention focuses on introducing improved (open-pollinated) nutrient-rich vegetable varieties suitable for growing in a container home garden and for which seeds are locally available. | | | | | | | |
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| 2. Objectives | | | | | | | |
| 2.1 To train rural households in container vegetable gardening techniques including container garden establishment, planting bed preparation, compost making, and pest and disease management.  2.2 To train women in processing and preservation of the nutritional content of vegetables during cooking, preparation of nutritious and safe meals. | | | | | | | |
|  | | | | | | | |
| 3. Research questions | | | | | | | |
| 3.1 Can training on container gardening improve the dietary quality and household nutrition security in rural households in Northern Ghana? | | | | | | | |
|  | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | |
| 4.1 Demographic, socio-economic, and container home garden information will be collected during household interviews using a structured questionnaire.  Household food intake will be assessed by using a semi-quantitative method based on recall of foods consumed by the household during the 24 hours preceding the survey from the household member who prepared the previous day’s meals.  The main independent variable will be the production and consumption of nutrient-dense foods.  Household food security will be assessed by using Food Consumption Score (FCS) and individual and household dietary diversity. | | | | | | | |

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| 5. Data to be collected and uploaded on Dataverse | | Responsibility/Institute |
| Is the collected data part of a multi-year experiment/trial? | | Yes |
| 5.1 Data on number of households trained, beneficiary awareness of the nutritional values and preparation of fruits and vegetables, dietary diversity will be assessed at end of activity. | | Mahama Saaka/UDS |
|  | | |
| 6. Milestones | | |
| Deliverables | Means of verification | Date of Delivery |
| 6.1 Training of households in container gardening | Training report submitted to IITA | Dec. 2021 |
| 6.2 Provision of knowledge and dietary practices regarding fruits and vegetables | Technical evaluation report of intervention published on CG space | Jun. 2022 |
| 6.3 An article on improving household diet diversity through promotion of vegetable container gardening | Article available online | Aug. 2022 |
| 6.4 Contrbution to WA handbook | Contributions submitted to the chief scientist | Throughout the year |

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| 7. Sustainable intensification indicators | | | | | |
| Domain | Indicators | Metric & Scale | Approach  Used in Data Collection | Before Intervention | After Intervention |
| 7.1 Productivity | NA |  |  |  |  |
| 7.2 Environmental | NA |  |  |  |  |
| 7.3 Economic | NA |  |  |  |  |
| 7.4 Social | NA |  |  |  |  |
| 7.5 Human | Nutrition | Minimum dietary diversity(that is eating from 5 food groups) in the past 24 hours before survey  Nutritional status (stunting, wasting and underweight) of children under 5 years at household level | Household nutrition survey  Anthropometric assessment | 25.7 % of children aged 6-23 months who meet the minimum dietary diversity    25.1 % stunted, 10.6 % wasted and 18.5 % underweight | At least 50.0 % children aged 6-23 months  19.0 % stunted, 5.6 % wasted and 12.5 % underweight |
|  | Capacity to experiment | Number of new practices tested by women of childbearing age | Routine monitoring | Proportion of households having homestead container gardens = 0 |  |

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| 8. How will scaling be achieved? |
| The results of nutrition interventions may guide stakeholders including Agricultural Extension Officers and development practitioners to extend the container garden technology to other communities. Furthermore, scaling up nutrition and agricultural interventions entails identifying those programs and practices of proven efficacy. Therefore, a successful outcome of this intervention study has a great potential for replication in other countries as well when the results are published. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| This activity has close links to Sub-activity GH1115-20 which identified varieties of vegetable species adapted to Northern Ghana in the dry season, Sub-activity GH1116-20 which aimed to improve the capacity of vegetable farmers on vegetable gardening, and post-harvest techniques.  Targeting of nutrition-specific interventions will primarily be based on the vulnerability of households to food insecurity and the high prevalence of undernutrition*.* Activities will be implemented in line with the Africa RISING overall strategic partnerships and geographical targeting ensuring convergence of nutrition interventions with other interventions and stakeholder activities (including livestock and crops) to focus on the same locations with complementary services to increase the impact of each other's actions. |
|  |
| 10. Custom indicators:   * Number of farmers trained in container gardening at household level * Number of households that have successfully adopted container home gardening technology |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing? Under-nutrition effects on human capital resource |
| 11.2 Who is your target audience? e.g. extension agents, farmers, or policymakers: Farm families |
|  |

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| --- | --- |
| 12. Budget (US$) | |
| Budget Line | UDS-SoH |
| Personnel | 4,500 |
| Services | 3,500 |
| Supplies | 3,000 |
| Travel | 2,500 |
| Overhead (15%) | 2,025 |
| Total | 15,525 |
| Budget Justification: This additional budget request is warranted because the initial planned 12 monthly nutrition education sessions in the intervention communities have now been revised to 18 months to maximize the effectiveness of behavioral interventions being implemented. The additional 6 months implementation duration will incur additional funding as estimated here. | |

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| 13. Gantt chart |  |  |  |  |  |  |  |  |  |
| Year/month | 2021 | | | 2022 | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
| Nutrition education on nutritional value and processing fruits and vegetables to farmer groups |  |  |  |  |  |  |  |  |  |
| Supervision of field activities |  |  |  |  |  |  |  |  |  |
| End-line evaluation of intervention (Training &data collection) |  |  |  |  |  |  |  |  |  |
| Data processing and analysis |  |  |  |  |  |  |  |  |  |
| Manuscript preparation and publication |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 2: GH2122-21** | | | | | | |
| Outcome 2: More farmers and farm families in the intervention communities are adopting technologies and practices to improve nutrition, food and feed safety, post-harvest handling and value addition | | | | | | |
| a. Output 2.1 | Improved technologies, practices and habits to increase production and consumption of diverse and more nutritious food by farm families, especially by women and children are developed | | | | | |
| b. Activity 2.1.2 | Train farm families, especially women, to produce and consume diverse and more nutritious food | | | | | |
| c. Sub-activity GH2122-21 | Engaging men to increase support for optimal child feeding practices using the Care Group Approach/Model | | | | | |
|  |  | |  | | | |
| d. Research team |  | |  | | | |
| Name | Institution | | Role | | | |
| Mahama Saaka | UDS- Community Nutrition | | Sub-activity leader; coordination of project activities | | | |
| Chrisantus Daari | Ghana Health Service | | Training of men’s groups, data collection, and compilation of monthly reports on activities | | | |
| Kofi Evam Glover | UDS- Community Health Dept. | | Social scientist to assist with the conduct of a qualitative formative study on gender issues on nutrition at community level | | | |
| Eric Nang | Ghana Health Service | | Training of men’s groups, data collection, and compilation of monthly reports on activities | | | |
| Khadija Wemah | Ghana Health Service | | Monitoring of subdistrict field activities including delivery of nutrition education, men’s group meetings, and home visits | | | |
| Benedict Ebito Boyubie | IITA | | Development of data collection tools, training of the research team on Feed the Future indicators and supporting data collection to track output level and Feed the future indicators,  Ensuring data upload on DataVerse | | | |
|  | | | | | | |
| e. Student(s) | | | | | | |
| Name | Institute | | Degree | Start | | End |
| NIL |  | |  |  | |  |
|  |  | | | | | |
| f. Location(s) | 25 communities in 5 districts (Savelugu, Tolon, Wa West, Nadowli, and Kassena-Nankana) of northern Ghana (This expands beyond the 12 Africa RISING communities | | | | | |
|  |  | | | | | |
| g. Start | July 2018 | | | | | |
|  |  | | | | | |
| h. End | June 2022 | | | | | |
|  |  | | | | | |
| 1. Justification | | | | | | |
| This sub-activity started in July 2018 but was revised in October 2019 to include the participation of men in the care of children. The intervention is yet to be evaluated because monthly care groups nutrition education sessions were suspended in March 2020 because of COVID-19 demand for social distance. Also, funds for the 2020/2021 activities were received late in January 2021 which delayed the start-up of planned activities. This notwithstanding, there is steady progress towards the finalization of the targeted deliverables, but some further work needs to be carried out during a six-month extension to firm up conclusions from ongoing behavior change interventions. We are therefore taking advantage of the extension period to improve on the intervention fidelity and to consolidate/enhance the external validity of findings from the ongoing intervention. An extension of the period for implementing the sub-activity will therefore consolidate our work to assess the knowledge gap regarding whether men's involvement in nutrition education using the care groups model at the community level can lead to optimal child feeding practices.  In Ghana, most community programs seeking to improve the well-being of women and children target mothers and their children with little attention to fathers as key influencers. This approach of targeting women-only in health and nutrition programming overlooks the role men play in household health and nutrition. The solution to this challenge is being tested in our intervention by using appropriate nutrition behavior change communication approaches such as the involvement of men in nutrition education using the care groups model at the community level. There is great potential for fathers to make a difference in the quality of infant feeding practices, but they need the information to make a difference (Kenosi *et al*., 2011)[[33]](#footnote-34), (Tohotoa *et al*., 2009)[[34]](#footnote-35). Engagement of fathers by educating them on infant and young child nutrition including breastfeeding through men’s group activities may greatly improve infant feeding and health behavior (Sloand *et al.*, 2009)[[35]](#footnote-36), (Matovu *et al*., 2008)[[36]](#footnote-37) because they play a critical role in providing instrumental and emotional support to mothers and children. Interventions that involve men as agents of positive change in support of their partners to adequately feed their families may greatly improve infant feeding and health behavior (Sloand *et al.*, 2009)19 but the evidence is lacking in Ghana and therefore warrants more research in this area. This is an innovative training designed to provide nutrition messages through peer groups of mothers and fathers as a platform to leverage their roles in decision-making related to health and nutrition behaviors. | | | | | | |
|  | | | | | | |
| 2. Objectives | | | | | | |
| 2.1 To assess fathers’ involvement in childcare and feeding practices in Northern Ghana. | | | | | | |
| 2.2 To determine the effect of fathers’ participation in nutrition training sessions on child feeding practices and on the nutritional status of their children under three years | | | | | | |
|  | | | | | | |
| 3. Research questions | | | | | | |
| 3.1 Can men's engagement in nutrition education at the community levelimprove child feeding practices and child nutrition? | | | | | | |
|  | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | |
| A cluster non-randomized-controlled trial will be used to assess the effectiveness of engaging men in nutrition training on child feeding practices and the nutritional status of children. This will entail carrying out pre-post cross-sectional surveys. The sample size will be calculated that will be adequate with 80 % power to detect an effect size of 20 % at 95 % confidence level. Households with men participating in community nutrition training activities will constitute the intervention group whilst the comparison group will comprise households not involving men in such activities. At the cluster level, a sample size of 15 households with a male partner/caretaker and children under three years of age will be systematically selected across the 25 Africa RISING intervention communities. A difference-in-differences analysis will be used to calculate intervention effects. Adjusted odds ratios (AORs) and 95% confidence intervals (95% CI) of associated factors with the key outcome measures will also be estimated. | | | | | | |
|  | | | | | | |
| 5. Data to be collected and uploaded on DataVerse | | | Responsibility/Institute | | | |
| Is the collected data part of a multi-year experiment/trial? Yes | | |  | | | |
| 5.1 Study data (Monitoring and end line survey) | | | Mahama Saaka/UDS | | | |
| 5.2 Monitoring data (Care group on-going functionality data) | | | Mahama Saaka/UDS | | | |
|  | | | | | | |
| 6. Milestones | | | | | | |
| Deliverables | | Means of verification | | | Date of delivery | |
| 6.1 Report on evaluating the impact of the f intervention | | A link to the impact evaluation report will be shared in the semi-annual report to IITA | | | Jun. 2022 | |
| 6.2 A paper on “Using men engagement in nutrition trainingto improve child feeding practices/nutrition” | | Online publication | | | Aug. 2022 | |
| 6.3 Contribution to the WA handbook | | Submitted and accepted by chief scientist | | | Throughout the year | |

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| 7. Sustainable intensification indicators | | | | | |
| Domain | Indicators | Metric & Scale | Approach  Used in Data Collection | Before Intervention | After Intervention |
| 7.1 Productivity | Not applicable |  |  |  |  |
| 7.2 Environmental | Not applicable |  |  |  |  |
| 7.3 Economic | Not applicable |  |  |  |  |
| 7.4 Social | Not applicable |  |  |  |  |
| 7.5 Human | Nutrition | Minimum dietary diversity of children under 2 years at household level  Nutritional status (stunting, wasting, and underweight) of children under 5 years at household level | Household nutrition survey  Anthropometric assessment | 25.7 % of children meeting MDD  25.1 % stunted, 10.6 % wasted and 18.5 % underweight | 40.0 %  19.5 % stunted, 6.5 % wasted and 12.5 % underweight |
|  | Capacity to experiment | Number of new practices tested by women of childbearing age | Household survey | Level of male involvement in promoting infant feeding (35 %) |  |

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| 8. How will scaling be achieved? | | |
| The intervention is being carried out in strong collaboration with Ghana Health Service staff who will be able to extend the activities to other communities where they operate. | | |
|  | | |
| 9. How are the activities in this protocol linked to those of others? | | |
| Activities will be implemented in line with the Africa RISING overall strategic partnerships and geographical targeting ensuring convergence of nutrition interventions with other interventions and stakeholder activities that seek to deliver useful messages to community groups. | | |
|  | | |
| 10. Custom indicators  A published paper on the impact of the engagement of men on infant and young child nutrition education and nutrition practices | | |
|  | | |
| 11. Impact-based summary matrix | | |
| 11.1 What is the development challenge you are addressing? Under-nutrition effects on human capital resources | | |
| 11.2 Who is your target audience? Men’s groups, community opinion leaders including chiefs. | | |
|  | |
| 12. Budget (US$) |  | |
| Budget Line | UDS | |
| Personnel | 2,000 | |
| Services | 2,000 | |
| Supplies | 1,500 | |
| Travel | 2,000 | |
| Overhead (15%) | 1,125 | |
| Total | 8,625 | |
| Budget Justification: This additional budget request is warranted because some further work needs to be carried out in six months to maximize the effectiveness of ongoing behavior change interventions. The additional 6 months implementation duration will incur additional funding as estimated here. | | |

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| 13. Gantt chart | | | | | | | | | |
| Year/ month | 2021 | | | 2022 | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
| Monthly care group meetings with men and women |  |  |  |  |  |  |  |  |  |
| Supervision of field activities |  |  |  |  |  |  |  |  |  |
| Holding community durbars and special fathers’ days |  |  |  |  |  |  |  |  |  |
| Impact evaluation of intervention (Training &data collection) |  |  |  |  |  |  |  |  |  |
| Data processing and analysis |  |  |  |  |  |  |  |  |  |
| Manuscript preparation and publication |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 2: GH2211-21** | | | | | | | | | | | | | | |
| Outcome 2: More farmers and farm families are adopting technologies and practices to improve nutrition, food and feed safety, post-harvest handling and value addition | | | | | | | | | | | | | | |
| a. Output 2.2 | | | Postharvest technologies and practices to provide options for the food and feed sectors are tested and disseminated to farmers, through researchers, extension staff, and development partners. | | | | | | | | | | | |
| b. Activity 2.2.1: | | | Introduce, evaluate, adapt and disseminate existing postharvest technologies and practices | | | | | | | | | | | |
|  | | | Build capacity of farm families to reduce postharvest losses. | | | | | | | | | | | |
| c. Sub-activity: GH2211-21 | | | Evaluate the threshing efficiency of different maize shellers with regards to grain quality characteristics as influenced by different varieties and harvest timing | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | |
| Name | | | | | | Institution | | Role | | | | | | |
| Issah Sugri | | | | | | CSIR-SARI | | Lead Investigator and coordinates all activities | | | | | | |
| Mutari Abubakari | | | | | | CSIR-SARI | | Team Member and contributes to data collection | | | | | | |
| Robert K. Owusu | | | | | | CSIR-SARI | | Data collection and analysis | | | | | | |
| Kotu Bekele | | | | | | IITA | | Socio-economic analysis | | | | | | |
| Abdul-Rahman Nurudeen | | | | | | IITA | | Team member offers agronomic support | | | | | | |
| Benedict Boyubie | | | | | | IITA | | Compilation of FtF indicators and ensuring data upload | | | | | | |
|  | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | | Degree | | Start | | End |
| Nil | | | |  | | | | | |  | |  | |  |
|  | |  | | | | | | | | | | | | |
| f. Location(s) | | UER (Nyangua, Tekuru, Bonia, Sambligo), NR (Doku, Tibale) | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| g. Start | | September 2019 | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| h. End | | June 2022 | | | | | | | | | | | | |
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| 1. Justification | | | | | | | | | | | | | | |
| This study emphasizes the emerging role of mechanized harvesting and threshing operations in northern Ghana and identifies options to address their availability, cost, adoption, and operational efficiencies. The crops of emphasis are maize, groundnut, and soybean. These crops are among the dominant food crops in northern Ghana due to their potential contribution to income, food security, and household nutrition. Both their production and value addition processes are strongly supported by Ghana’s Government Planting for Food and Jobs Programme, which commenced in 2017. Evidence shows that these crops will continue to be the important drivers of agricultural growth in northern Ghana (MoFA, 2018[[37]](#footnote-38)). Consequently, commercial production of these crops has noticed ascendency across districts in northern Ghana by both medium and large-scale entrepreneurial farmers. Nonetheless, high post-harvest losses have been identified as a crucial challenge to achieving food and nutrition security in sub-Saharan Africa ([Affognon](file:///C:/Users/wbrooijmans/AppData/Local/Microsoft/Windows/INetCache/Content.Outlook/Documents/Postharvest%20loss%20article%20II/S0305750X14002307%20(1).htm) et al., 2015[[38]](#footnote-39); Sugri et al., 2021[[39]](#footnote-40)). As the commodity moves from the farm to fork, losses may occur in 3 main categories: (i) quantitative or physical losses in weight of the product; (ii) loss of quality which changes the appearance, taste, texture, or nutritional value of the product; and (iii) loss of opportunity for value of the product. Improved technologies to reduce losses at each node of the postharvest chain are critical for reducing overall losses. This study seeks to minimize quantitative losses occurring at harvest and threshing of maize, soybean, and groundnut.  Our previous studies to characterize harvesting operations in northern Ghana revealed the following interlinked challenges that affect losses in commodities both in quantity and quality:   * Harvesting of the main cereals (maize, sorghum, millet, rice, cowpea, groundnut, and soybean) coincide from September to December each year * Most farmers engage in multiple crop production and so harvesting of these crops necessarily overlap * Access to post-harvest mechanization such as threshing machines is either not available or too costly for smallholder farmers * Most of the post-harvest operations are carried out entirely by women using human energy or traditional and less efficient farm implements * The small-scale nature of production limits the uptake of improved technologies with the potential to reduce costs and increase the efficiency of post-harvest operations * Access to family labor is being reduced across farm households for a complex of socio-economic reasons * Climate variability poses severe threats concerning harvesting, drying, and associated effects on grain quality, specifical pests in grain, and mycotoxin contamination   To overcome some of these challenges, the IITA-Africa RISING Project, working in collaboration with several partners in Northern Ghana over the years, has sought to bridge such knowledge gaps at both the production and postharvest stages. Currently, the project is promoting semi-mechanized diesel-powered maize shelling machines (R170A Max. Engine power: 4.95Ps, 12hr rated power 4.5Ps, declared speed: 2,600r/min, Average weight 43Kg) in the communities to improve postharvest activities. Some amount of work has been carried out to assess and describe the dynamics and the rules of engagement among group members, non-group members, and other stakeholders with whom they are interacting to make use of the maize sheller. These activities are to ensure that more farmers and farm families are adopting technologies and practices to improve nutrition, food and feed safety, post-harvest handling, and value addition. | | | | | | | | | | | | | | |
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| 2. Objectives | | | | | | | | | | | | | | |
| 2.1 Reduce postharvest losses by evaluating and promoting the use of improved, simple, and efficient threshing machines for smallholders | | | | | | | | | | | | | | |
| 2.2 Evaluate the operational and economic efficiencies of different threshing machines which are appropriate for small and medium-scale growers | | | | | | | | | | | | | | |
| 2.3 Promote, demonstrate and train beneficiary farmers on factors affecting threshing performance | | | | | | | | | | | | | | |
| 2.4 Develop technical materials (technical leaflets and research briefs) to build the capacity of farm families and other actors on best technologies and practices to reduce postharvest losses | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | |
| 3.1 How can we improve harvesting/postharvest activities among small and medium-scale farmers? | | | | | | | | | | | | | | |
| 3.2 How can we save farm-family time and energy for other productive enterprises? | | | | | | | | | | | | | | |
| 3.3 How can manual activities be reduced to make agriculture attractive and profitable to women, youth, and medium-scale farmers? | | | | | | | | | | | | | | |
| 3.4 How can access to threshing machines be enhanced? | | | | | | | | | | | | | | |
| 3.5 How can farmers' knowledge of factors contributing to postharvest losses be improved? | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | |
| Over the last 2 years, the study concentrated on the threshing performance of maize and soybean. The emphasis was to characterize the efficiency of different threshing machines and related services in those districts. The work in 2021/22 will focus on groundnut post-harvest operations. Different approaches involving field measurements of shelling losses, focus group discussions, farmer field schools, use of technical leaflets, and key informant interviews are being employed. All activities are concentrated in 3 districts, namely Bongo and Kassena Nankane East Municipal (KNEM) in the Upper East Region and Savelugu District in the Northern Region. Purposive sampling targeting farmers who essentially employ maize, groundnut, and soybean threshing machines and related services are being employed to generate the required data. An interview guide has been developed to generate information on production operations, farm size, yield, postharvest operations, factors influencing the use of threshing machines, and associated challenges. This year, emphasis will be placed on groundnut harvesting, drying, and storage; due to the significance of these operations on aflatoxins and food safety issues.  **Analysis of groundnut harvest value chain operations**  The study involves integrated postharvest practices which can be adapted to improve efficiency at harvesting, drying, storage, and shelling operations. An in-depth analysis of the strengths, weaknesses, opportunities, and threats (SWOT) is being conducted to map opportunities to make groundnut postharvest operations efficient and friendlier to growers. The second step will involve analysis of the hazards and critical control points in the postharvest chain to improve food safety and reduce the risk of aflatoxins.  **Determination of** **threshing performance characteristics**  The following threshing performance indices were evaluated in groundnut.   * Throughput capacity * Threshing efficiency * Grain physical purity * Grain moisture content * Threshing losses * Benefit-cost ratios   **Characterization of groundnut and soybean maturity indices**  Knowledge of maturity indices and time to harvest exerts significant effects on grain yields, threshing losses, flour quality, insect pest damage, and mycotoxin accumulation. Shatter losses, sprouting, and mycotoxins accumulation are challenges in groundnut if harvesting is delayed. The activity is to facilitate farmers to determine the optimum harvest indices to maximize maize, groundnut, and soybean yields and reduce other risks associated with late harvesting. Pictorial maturity scale will be developed and printed in poster form for use by farmers and agricultural extension officers.    **Farmer Field Schools (FFS)**  Participatory demonstration and FFS sessions will be organized in 6 Africa RISING communities. This will be accompanied by 2-hours of technical information on factors affecting harvest losses and shelling performance.  **Training of Regional Actors**  Two regional-level training of actors (lead farmers, Agricultural Extension Agents, and Regional Agricultural Development Officers) will be organized on the emerging role of agricultural mechanization in increasing productivity and food security. | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded | | | | | | | | | | | |  | | |
| Is the collected data part of a multi-year experiment/trial? Yes | | | | | | | | | | | | Responsibility | | |
| 5.1 Field protocols and field survey tools developed to collect data | | | | | | | | | | | | SARI | | |
| 5.2 Field measurement data on performance efficiency characteristics (machine productivity, % threshing losses, % grain purity, % threshing efficiency, % grain moisture) | | | | | | | | | | | | SARI | | |
| 5.3. Training materials, technical leaflets, and training reports compiled | | | | | | | | | | | | SARI | | |
| 5.4 Processed data in Excel and SPSS and other software | | | | | | | | | | | | IITA | | |
|  | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | |
| Deliverables | | | | | | | | | | | Means of verification | End date | | |
| 6.1. Conduct field surveys and field measurement of shelling performance of groundnut shelling operations. | | | | | | | | | | | Link to training report and annual report | Feb. 2022 | | |
| 6.2. Map opportunities to increase efficiency at groundnut harvesting, drying, and shelling operations | | | | | | | | | | | Link to training report and annual report | Feb. 2022 | | |
| 6.3 Analysis of the hazard and critical control points in the postharvest chain to improve food safety and reduce the risk of aflatoxins | | | | | | | | | | | Link to training report and annual report | May 2022 | | |
| 6.3 Harmonize data on socio-economics, benefit-cost, and gender | | | | | | | | | | | Annual report | Jun. 2022 | | |
| 6.4. Farmer field schools and trainings organized in 6 selected project communities | | | | | | | | | | | Link to training and annual report | Dec. 2022 | | |
| 6.5. Develop additional technical guides to characterize maturity indices to improve groundnut and soybean harvesting and threshing | | | | | | | | | | | Technical leaflets and annual report | Feb. 2022 | | |
| 6.6. Conduct regional level trainings of actors on the emerging role of agricultural mechanization in increasing productivity | | | | | | | | | | | Training report | Dec. 2021 | | |
| 6.7. Data on the number of farm families utilizing and seeking threshing machines in communities generated | | | | | | | | | | | Monitoring evaluation reports | Jun. 2022 | | |
| 6.8. Develop a second technology brief on the role of groundnut threshing machines in improving postharvest activities published | | | | | | | | | | | Link to the publication, print out | Nov. 2021 | | |
| 6.9. Process data on dataverse; and develop 1 manuscript from multi-year data | | | | | | | | | | | Link to data source and publication available | Feb. 2022 | | |
| 6.10. Networks provided for farmers and communities to access threshing, mechanization, and related services | | | | | | | | | | | List of FBOs networked | Jun. 2022 | | |
| 6.11. Contribute towards the development of the West Africa Handbook | | | | | | | | | | | Book chapter published | Mar. 2022 | | |
|  | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | |
| Domain | Indicators | | | | Metric & Scale | | Approach used in data collection | | Before intervention | | | | After intervention | |
| 7.1 Productivity | Food saved | | | | losses (%) | | Survey data, Key informant interviews,  Field measurement | | Threshing losses are estimated as 1-5% in maize, 1-15% in soybean, and 1-22% in groundnut | | | | Significant increase in household food access due to reduction in food waste | |
| 7.3 Economic | Profitability  Time saved  Labor use | | | | % losses  Net income,  Number of hour/crop, drudgery score | | Field survey,  Price differentials  Recall surveys | | Time spent in manual harvesting operations in maize was 18 - 22 man-days/ha (144 -176 hours/ ha);  Time spent in soybean harvesting operations (harvesting, conveying, threshing) was 14- 18 man-days/ha (112-144 hours/ ha)  Time spent in groundnut harvesting operations (harvesting, stripping, and drying) was 30- 35 man-days/ha (240-20 hours/ ha) | | | | Access to threshing machines and services leads to 40% reduction of losses.  50% reduction in economic time spent on harvesting threshing operations | |
| 7.4 Social | Social cohesion,  Leisure time,  Group membership, participation in off-farm enterprise | | | | Time saved (hr)  Participation in FBO activities | | Recall of labor time, direct observation,  Key informant interviews | |  | | | | 50% reduction in economic time spent on harvesting threshing operations | |
| 7.5 Human | Food security (availability and access)  Nutrition | | | | Number of hunger months (months) at household income  Food consumption score | | Recall of food used  Recall surveys | | High harvest and postharvest losses and risk of aflatoxins and other mycotoxins due to late harvesting | | | | Reduction in number of food hunger months at household level.  Access to safe and nutrition food | |

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| 8. How will scaling be achieved? |
| 8.1. At the community level, this will be achieved through i)community training and demonstrations, ii) by linking the FBOs to the mechanization unit of MoFA for future capacity training and, iii) by linking the groups to local equipment manufacturers and private individuals who offer such related services, iv) training of regional actors |
| 8.2 Results of these activities will be presented at workshops and conferences to share our experiences with partners engaged in mechanization targeted at improving the operational efficiency of smallholder farmers |
| 8.2 Using technology briefs and technical leaflets, the study results will be presented in simple text for use by the public and non-scientific audiences |
| 8.3. The Project Team has been approached by the Soybean Innovation Lab (SIL) seeking to learn how they can potentially stimulate a similar approach around technology transfer mechanisms |
| 8.4. Training of regional actors and partners is expected to increase coverage of beneficiaries reached on improved postharvest practices |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| 9.1. Training of regional and district actors is expected to build partnerships with farmers, local communities, and research and development partners to achieve significant loss reduction |
| 9.2. Data collection will identify gender issues, related socio-economic benefits as well as benefit-cost analysis of utilizing threshing machines. |
|  |
| 10. Custom indicators |
| * Produce 1 technical report on improved harvest and threshing practices * Produce 4 technical leaflets on groundnut and soybean harvest maturity indices * 2 journal articles submitted/published Extension guide materials * 6 farmer field days organized on best harvest practices and operations in communities * Conduct 2 field surveys intervention communities on quality control and gender issues * Organize 2 regional training sessions on postharvest mechanization. * Produce 1 policy brief on role threshing machines on reducing drudgery and saving labor * Submit 2 chapters on WA Handbook * Activity reports are captured in the semi-annual CSIR-SARI Reports to IITA |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing? |
| Post-harvest losses have been identified as a crucial challenge to achieving food and nutrition security in sub-Saharan Africa. Thus, the deployment of improved technologies to reduce postharvest losses is critical to achieving the United Nations Sustainable Development Goals (UN-SDG 2); which seeks to end hunger, achieve food security and improve nutrition, and promote sustainable agriculture. High post-harvest losses represent a significant risk to producers, governments, and the environment since economic resources would have been expended in the production process. But, advances in postharvest technologies over the last decades make loss reduction much possible if the stakeholders take necessary actions. This study engages integrated approaches to mitigate the primary causes of losses at harvest and threshing stages. The sub-activities are expected to address the following major development challenges: (i) low farm productivity leading to food insecurity in communities, (ii) high postharvest losses, and drudgery associated with manual threshing operations (iii) little time availability by farmers to participate in off-farm enterprises such as dry-season gardening (iv) low food quality and safety resulting in poor household nutritional status and income, (v) high aflatoxin levels due to poor harvest, drying and storage practices |
| 11.2 Who is your target audience, e.g. extension agents, farmers, or policymakers? |
| Among the beneficiaries are public and private extension agents, farmers, implement manufacturers and retailers, consumers, and policymakers |

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| --- | --- |
| 12. Budget (US$) | CSIR-SARI |
| Personnel | 2,500 |
| Services | 4,000 |
| Supplies | 2,841 |
| Capital |  |
| Travel | 3,710 |
| Overhead (15%) | 1,958 |
| Total | 15,009 |

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| 13. Gantt chart | | | | | | | | | |
| Month/ year | 2021 | | | 2022 | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
| Conduct field surveys and field measurement of shelling performance of groundnut shelling operations. |  |  |  |  |  |  |  |  |  |
| Survey to map opportunities to increase efficiency at groundnut harvesting, drying, and shelling operations |  |  |  |  |  |  |  |  |  |
| Analyze socio-economic, benefit-cost, and gender issues different postharvest operations characterized |  |  |  |  |  |  |  |  |  |
| Regional training of actors |  |  |  |  |  |  |  |  |  |
| Farmer schools to increase utilization and adoption of threshing machines in communities. |  |  |  |  |  |  |  |  |  |
| Develop additional technical guides to characterize maturity indices to improve groundnut and soybean harvesting and threshing activities |  |  |  |  |  |  |  |  |  |
| Process data and upload onto Dataverse |  |  |  |  |  |  |  |  |  |
| Develop 1 manuscript for publication from 2 years of fieldwork |  |  |  |  |  |  |  |  |  |
| Link farmers to artisans and mechanization unit of MoFA |  |  |  |  |  |  |  |  |  |
| Data on farm-families utilizing and seeking threshing machines in communities |  |  |  |  |  |  |  |  |  |
| Contribute to the WA Handbook |  |  |  |  |  |  |  |  |  |
| Provide information for M&E for reports |  |  |  |  |  |  |  |  |  |
| Provide semi-annual reports and review meetings |  |  |  |  |  |  |  |  |  |

GH2212 OUT?

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| **Africa RISING West Africa Activity Protocol – Outcome 3: GH3111-21** | | | | | | | | | | | | | | |
| Outcome 3: Farmers and other value chain actors have greater and equitable access to production assets and markets (input and output) through enabling institutions and policies | | | | | | | | | | | | | | |
| a. Output 3.1 | | | Improved policies and institutional arrangements to increase participation of farm families, especially women and youth in the output and input markets and decision-making are developed | | | | | | | | | | | |
| b. Activity 3.1.1 | | | Address constraints to and opportunities for improving access to the output and input markets by actors including paying particular attention to women and youth in the target area | | | | | | | | | | | |
| c. Sub-activity GH3111-21 | | | Strengthen the technical, managerial, and organizational capacities of the major actors in the small ruminant value chain through institutional structures such as Producers’ Association, Value Chain Development Units, District Assemblies, Community Based Organizations, Traders’ Associations, Processors’ Associations, Transporters, and Input Dealers Associations | | | | | | | | | | | |
|  | | |  | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | |
| Name | | | | | Institution | | | | Role | | | | | |
| Franklin K. Avornyo | | | | | ARI | | | | Coordination of the sub-activity, provision of supervision and general control on the project as well as technical backstopping, training of farmers, data collection, data analysis review of reports, and final reporting | | | | | |
| Mohammed T. Shaibu | | | | | ARI | | | | Implementation of project activities, project review, reporting, and lead in the design of field instruments | | | | | |
| Emmanuel Panyan | | | | | ARI | | | | Implementation of project activities, project review, and reporting | | | | | |
| Head of Department of Agriculture, Kassena-Nankana Municipal  Head of Department of Agriculture, Wa West District | | | | | Department of Agriculture (DoA) | | | | Help link the various actors and increase their access to technologies and information as well as lead in the execution of complementary activities | | | | | |
| Benedict Boyubie | | | | | IITA | | | | FtF indicators and data upload on DataVerse | | | | | |
|  | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | | Degree | | | Start | End |
| NIL | | | |  | | | | | |  | | |  |  |
|  | |  | | | | | | | | | | | | |
| f. Location(s) | | 1. Upper East Region: Kassena Nankana Municipal and Kassena Nankana West  2. Upper West Region: Wa West and Wa Municipal | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| g. Start | | August 2019 | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| h. End | | June 2022 | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | |
| The economy of Ghana is largely agricultural and contributes about 19.7% of the Gross Domestic Product. Crop-based agricultural products account for 14.5% with only 2.7% contributed by domestic animal production (GSS, 2019[[40]](#footnote-41)). Frozen fish and meat products are listed among the top ten imported commodities to Ghana (UN Comtrade, 2017[[41]](#footnote-42)). The low level of in-country animal products contributes to the negative deficit. This imbalance in crop and animal agriculture is also reflected on the plate of everyday Ghanaians with more than 70% of protein coming from starchy foods such as cereals, roots, and tubers. Inadequate intake of animal protein has contributed to the prevalence of stunting among school children and alarmingly increasing population with overweight issues in the country (FAO-STATS, 2010[[42]](#footnote-43)).  Most of the country’s livestock-related activities take place in northern Ghana which is considered the breadbasket of the country. Therefore, scaling up agriculture as a means for poverty alleviation has long been proposed with several interventions initiated. However, the impact of these has been minimal due to multiple factors.  The livestock sector in Ghana has not been given the needed attention. In contrast, Burkina Faso has a National Director in charge of Value Chain Development in the Directorate of Animal Resources and Fisheries and is responsible for all livestock value chain development activities of the country. The focus of the Government of Ghana is also on the development of agribusiness models and the policy is to use the value chain approach. Consequently, there is an Agribusiness unit at the headquarters of the Ministry of Food and Agriculture but no unit on value chain development has been created. There appears to be no clear policy guideline governing the operation of the value chain approach. This notwithstanding, the Government of Ghana has, in recent times, rolled out plans and projects in which the small ruminant sector is one of the key commodities. Under the Government’s flagship project on ‘Rearing for Food and Jobs’, small ruminant production is being promoted and there is an intention to revive a Meat Processing factory in Zuarungu in the Upper East Region. For now, as far as the small ruminant value chain is concerned, the focus of the Ministry of Food and Agriculture is on the production side, and issues concerning trading and processing may be subsumed under the Ministry of Trade and Industry. Feedback from traders and processors points to a collapsing small ruminant business.  Small ruminant producers in Ghana are not organized into associations while in Burkina Faso, it is a requirement for producers to form cooperatives, and projects work with cooperatives. Their feed sellers are also organized. The Government of Burkina Faso has in recent times been organizing free vaccination exercises against Peste des petits ruminants (PPR) for farmers’ small ruminants and this intervention has helped to reduce their small ruminant mortality rate to around 12%. In Ghana, the small ruminant mortality rate exceeds 30%. There is a need to strengthen the linkage between veterinary services and producers in Ghana. Small ruminant value chain actors in Burkina Faso are eligible to access substantial amounts of loans (CFA 3,000,000 up to even CFA 500,000,000).  It is for these disparities that the leadership of the Ghana National Livestock Breeders’ and Traders’ Association has been blaming the Ghana Government for the livestock industry’s misfortunes, citing neglect as the main cause. However, the sector has a huge potential to offer employment, particularly, in the upstream segment of the value chain, to the youth in the country. The incidence of the activities of suspected Islamist militants is resulting in the death of Burkina Faso soldiers and farmers and farm families are fleeing their homes in the north and eastern part of Burkina Faso because their security is threatened. The urgency for Ghana to assume responsibility and complement the efforts of Burkina Faso is becoming more obvious. In this regard, an experience can be drawn from Burkina Faso, on the development of the small ruminant value chain, and organizational, managerial, and technical capacities that need to be built for benefits to accrue. Following the above, we will therefore consider the activities associated with small ruminant value chains at targeted Africa RISING project communities and where work to improve the effective functioning of the entire small ruminant value chain by pushing for MoFA to facilitate the development of the small ruminant value chain. In other words, there are other important issues such as the formation of relevant partnerships and capacitating the Ministry of Food and Agriculture to play a lead role in strengthening the capacities of actors. Addressing these constraints will bring help to farmers and other actors including women and the youth along the small ruminant value chain. | | | | | | | | | | | | | | |
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| 2. Objectives | | | | | | | | | | | | | | |
| 2.1 Develop a framework for expanding fully the policy guideline for the livestock value chain in Ghana and make it available to MoFA for further development | | | | | | | | | | | | | | |
| 2.2 Identify and form more relevant partnerships that will enhance the development of the small ruminant value chain. The team plans to meet with the Voluntary Service Organization, Ghana Agricultural Sector Investment Programme (GASIP), and others | | | | | | | | | | | | | | |
| 2.3 Contribute towards making Innovation Platforms (IP) to be sustainable through the building of entrepreneurial capacities and linking organized groups into bigger groups | | | | | | | | | | | | | | |
| 2.4 Conduct further evaluation study on sustainable intensification (SI) indicators and already implemented interventions to more accurately measure impact and learn lessons | | | | | | | | | | | | | | |
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| 3. Research questions | | | | | | | | | | | | | | |
| 3.1 How should an effective framework look like for the development of a policy guideline for the livestock value chain in Ghana? | | | | | | | | | | | | | | |
| 3.2 What partnerships will be relevant in supporting the growth of the small ruminant value chain to the benefit of value chain actors? | | | | | | | | | | | | | | |
| 3.3 How can Innovation platforms be made functional and sustainable? | | | | | | | | | | | | | | |
| 3.4 How does a project aimed at strengthening the small ruminant value chain impact on Africa RISING project community members including women and the youth? | | | | | | | | | | | | | | |
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| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | |
| **Develop a framework for expanding fully the policy guideline for the livestock value chain in Ghana**  Currently, Ghana lacks clear policy guidelines for the functioning of the livestock value chain. The purpose is not to develop a full policy guideline as that may be beyond the scope of this project. Besides, developing a national policy document requires national stakeholder consultative meetings. The objective, however, is to take a step beyond the status quo, to develop a framework for the policy document. The framework shall involve developing the overall content, in various sections of the document, and making it available to the Ministry of Food and Agriculture of Ghana, the Ministry in charge of, among other roles, policy development of Ghana’s agricultural sector. To obtain a comprehensive framework, other policy documents (Tree crop development policy document) shall be reviewed. Relevant stakeholders, either institutions or individuals, shall be contacted for their inputs.  **Identify and form more relevant partnerships for enhancing the development of the small ruminant value chain**  Partnership formation is an important tool for building sustainability. The entry points of most development work are through existing groups and associations at project sites. In the third phase, more partners would be explored, and presentations on how the small ruminant value chain functions in both sites would be made. During such opportunities, emphases would be made for such partners, especially research and development organizations, to work with actors that the Africa RISING project has worked with. Already two breeding rams have been purchased by a different project that the Animal Research Institute is implementing in the Upper West Region., to supply them to Wa West Africa RISING project farmers to improve their productivity.  **Contribute towards making the Innovation Platforms (IP) sustainable, building entrepreneurial capacities, linking the organized groups into bigger groups**  Resource persons with business minds shall be contacted to provide entrepreneurial capacity building to the actors. The training on business development would also include how to sustain groups. The Innovation Platforms shall be linked to already existing platforms at the regional level, in both project sites. This would be done through group meetings. Discussions on how the district/municipal and regional level platforms can work together would be explored, and information on the same would be documented.  **Conduct an evaluation study on SI indicators and the associated interventions**  Further evaluation study will be conducted on Sustainable Intensification indicators and interventions that have been implemented to better assess the impact and learn lessons. Putting into consideration selected SIAF domains, the study will assess small ruminant productivity; soil quality, income, labor and innovativeness of project farmers. The project will continue to scout for success stories. | | | | | | | | | | | | | | |
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| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | | | Responsibility/Institution | | |
| 5.1 Qualitative data will be collected by way of informal interviews and sharing of experiences and lessons | | | | | | | | | | | | CSIR-ARI (Avornyo) | | |
| 5.2 Number of participants disaggregated by sex and actor groups and type of training or capacity building activity | | | | | | | | | | | | CSIR-ARI (Avornyo) | | |
| 5.3 Evaluation survey data on the sustainable intensification indicators and other project interventions | | | | | | | | | | | | CSIR-ARI (Shaibu) | | |
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| 6. Milestones | | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | | Delivery date | |
| 6.1 A comprehensive framework for the development of a policy guideline for the small ruminant value chain in Ghana | | | | | | | Copies of the framework document available at CSIR-ARI, IITA and MoFA-APD | | | | | | Jun. 2022 | |
| 6.2 Complete manuscript on an assessment of small ruminant value chain in Ghana and Burkina Faso submitted for publication in a peer-review journal | | | | | | | Confirmation by journal of submission of a manuscript | | | | | | Aug. 2022 | |
| 6.3 Reports on discussions of new and additional identified partners associated with the development of the small ruminant value chain | | | | | | | As part of progress or final report, meeting reports containing:  - potential and new partners of the small ruminant value chain  - lists of attendance | | | | | | Jun. 2022 | |
| 6.4 Reports on discussions of Innovation platform sustainability, business development and linked smaller and bigger groups of actors of the small ruminant value chain | | | | | | | As part of progress and final report, meeting report containing:  - information on how to make an optimum business out of small ruminants, cost-benefit analysis of small ruminant activities  -lists of attendance | | | | | | Apr./May 2022 | |
| 6.5 Complete manuscript on “Impact of sustainable intensification indicators on the development of small ruminant value chains in Northern Ghana” | | | | | | | -Confirmation by journal of submission of manuscript | | | | | | Aug. 2022 | |
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| 7. Sustainable intensification indicators | | | | | | | | | | | | | | |
| **Domain** | **Indicators** | | | | | **Metric & Scale** | | **The approach used in data collection** | | | **Before intervention** | | | **After intervention** |
| 7.1 Productivity | Animal productivity | | | | | Animal numbers  (number/hh/yr) at the hh level,  Animal by-products  (by-product/hh/yr) | | Survey instruments | | | -Low number of animals (1,170 small ruminants belonging to 45 farmers in 2019),  -Few farmers (56%) vaccinate/treat their animals | | | -Animal numbers have increased by 120% offspring delivered every year and this birth rate will be higher than the mortality rate thereby allowing for offtake and/or increasing farmers’ small ruminant numbers  Improved use of improved breeds of small ruminants  More farmers (additional 79% farmers) vaccinate/treat animals |
| 7.2 Environmental | Soil biology  Soil chemical quality | | | | | Total carbon (% or mg/ha) at field level,  Soil pH at field level,  Soil nutrient levels at field level | | Soil sampling and analysis | | | Diminishing poor soils. 6.25 pH, 0.88% O.C., 0.04% N, 4.36 mg/kg P, 0.078 me/100 g K | | | Soil fertility improved due to increased use of organic manure by about 60% of the sample farmers interviewed,  6.37 pH, 0.99% O.C., 0.06% N, 18.84 mg/kg P, 0.158 me/100 g K |
| 7.3 Economic | Profitability  Labor requirement | | | | | Net income (total net income for small ruminant activities) at household level,  Labor requirement (hours) at hh level,  Farmer rating of labor at hh level | | Survey instruments | | | Mortality rate of animals decreased output and for that matter number of animals sold by a typical farmer | | | Increased number of females engaged in the sale of small ruminants to take care of household needs (e.g., food items, payment of bills and fees, etc.) |
| 7.4 Social | Gender equity  Collective action | | | | | Access to information at hh level,  Collective action groups at the community level | | Survey instruments | | | Low number of social groupings | | | Increased number of social groupings due to the formation of innovation platforms – the farmers belong to small ruminant producer groups at the community level |
| 7.5 Human | Nutrition  Capacity to experiment | | | | | Access to nutritious foods at hh level,  Number of new practices being tested at hh level | | Survey instruments | | | 38% of households eat twice while 52% eat thrice a day | | | - 25% of households eat twice a day and 75% eat thrice a day.  - More households ate food secure, can pay hospital bills, school fees, and eat more variety of foodstuffs |

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| 8. How will scaling be achieved? |
| Scaling will be done through the publication of manuscripts in peer review journals. Already, a handbook on small ruminant development has been developed that guides extension agents on the state and future pathways for the development of the small ruminant value chain and this has been published by the International Institute of Tropical Agriculture. Scaling would also be done at RELC meetings where different stakeholders meet to share research findings. Though a sister project being under implementation by CSIR-Animal Research Institute, two improved rams have been purchased to be supplied to farmers in the Upper West Region, particularly, two farmers who had participated in the Africa RISING project activities. Reports would be available on Animal Research Institute’s website. |
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| 9. How are the activities in this protocol linked to those of others? |
| The activities in this protocol are linked to two of the following other sub-activities under the Africa RISING project:   * Assessment of women and youth participation in maize and small ruminant value chains in Africa RISING project communities and markets to which the communities are linked. This activity is being undertaken in Ghana, with sub-activity number GH 3122-21 * Assess the impact of Innovation Platforms on SI technology uptake in Africa RISING interventions communities in Mali (sub-activity number: MA 4312-20)   The team shall explore more relations with other team members, as done during the West Africa planning meeting to tap what worked well in their various teams. |
|  |
| 10. Custom indicators |
| * Number of potential partners identified and contacted * Number of Sustainable/functioning innovation platforms * Number of linkages of smaller and bigger groups formed * Number of project reports produced * Number of journal articles/case studies submitted/published * Handbook chapter contribution |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing? |
| Weak linkages among actors in the small ruminant value chain in northern Ghana which if well addressed will enhance participation of smallholder small ruminant producers in the value chain thereby improving their income. |
| 11.2 Who is your target audience, e.g. extension agents, farmers, or policymakers?  Service providers, input suppliers, women, youth, small ruminant farmers, traders, transporters, processors, policymakers, and consumers |

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| 12. Budget (US$) | CSIR-ARI |
| Personnel | 15,526 |
| Services | 4,375 |
| Supplies | 1,505 |
| Capital | 0 |
| Travel | 5,421 |
| Overhead (15%) | 4,024 |
| Total | 30,851 |

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| 13. Gantt chart | | | | | | | | | | | | |
| Year/Month | 2021 | | | | | | 2022 | | | | | |
| Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
| Review of other policy documents to obtain a comprehensive policy document for the small ruminant value chain in Ghana  -Conduct individual and/or group (if possible) stakeholder discussions with key management staff of the Ministry of Food and Agriculture to solicit inputs into the development of the framework for the policy guideline. (See deliverable 6.1) |  |  |  |  |  |  |  |  |  |  |  |  |
| Review of literature to solicit relevant information for the development of a manuscript on an assessment of small ruminant value chain in Ghana and Burkina Faso. There shall be possible visits to livestock markets in project sites to unravel any uncertain information obtained during the baseline data collection. (Deliverable 6.2) |  |  |  |  |  |  |  |  |  |  |  |  |
| Identify and form relevant partnerships with say, NGOs, Municipal/District Assemblies, and Ministry of Food and Agriculture to strengthen the small ruminant value chain in Ghana. There are plans to form partnerships with Voluntary Service Organizations and GASIP among others. If possible, there shall be field visits with partners to link them to the Innovation Platforms, so that the partners keep them in mind in their future or ongoing work. Specifically, COWTRIBE, which is an NGO delivering vaccination services to livestock farmers’ animals, are potential partners to link with the farmers in the project sites. (Deliverable 6.3) |  |  |  |  |  |  |  |  |  |  |  |  |
| One training workshop in building entrepreneurial skills of Innovation platform members in each project site shall be organized. Established bigger groups at the regional level shall be linked to the smaller groups at the Municipal and District levels. (Deliverable 6.4) |  |  |  |  |  |  |  |  |  |  |  |  |
| Conduct to cover additional farmers, an evaluation study on Sustainable Intensification indicators, namely, actor organization, linkages, natural resource management, technology adoption, incomes, labor input, and small ruminant productivity as well as interventions that have been implemented to assess impact, learn lessons and identify success stories. Part of this work contributes to the manuscript on the impact of sustainable intensification indicators on the development of small ruminant value chains (Deliverable 6.5) |  |  |  |  |  |  |  |  |  |  |  |  |
| Monitoring and reporting |  |  |  |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 3: GH3112-21** | | | | | | | | |
| Outcome 3: Farmers and other value chain actors have greater and equitable access to production assets and markets (input and output) through enabling institutions and policies | | | | | | | | |
| a. Output 3.1 | Enabling policies and institutional arrangements to increase participation of farm families, especially women and youth in the output and input markets and decision-making are advocated for implementation by national governments, policymakers and development partners | | | | | | | |
| b. Activity 3.1.1 | Review of existing policies and institutional arrangements affecting equitable access to production assets and markets | | | | | | | |
| c. Sub-activity GH3112-21 | Analyze the enabling environment including policies and institutional arrangements and intervention to identify factors that enable the inclusion of women and youth along irrigated vegetable value chain in Ghana | | | | | | | |
|  | | | | | | | | |
| d. Research team | | | | | | | | |
| Name | Institution | | Role | | | | | |
| Thai Minh | IWMI | | The Senior researcher: responsible for the systemic analysis of the scaling pathway for irrigated vegetable value chain in Ghana and Mali. She will carry out data collection and analysis on SI indicators mainly on social and human conditions to evaluate holistic sustainability of the interventions | | | | | |
| National Researcher Scaling Innovations (TBD) | IWMI | | The National Researcher will support the data collection on the systemic analysis component | | | | | |
| Benedict Boyubie | IITA | | Support towards meeting project M&E requirements and FtF indicators while ensuring data upload on Dataverse | | | | | |
|  | | | | | | | | |
| e. Student(s) | | | | | | | | |
| Name | Institute | | | Degree | | Start | End | |
| NIL |  | | |  | |  |  | |
|  | | | | | | | | |
| f. Location(s) | National Level in Ghana; link to ground-level activities in Upper East Region, Ghana | | | | | | | |
|  |  | | | | | | | |
| g. Start | September 2020 | | | | | | | |
|  |  | | | | | | | |
| h. End | March 2022 | | | | | | | |
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| 1. Justification | | | | | | | | |
| In addition to the Bhungroo solar-based irrigation system and drip irrigation, several others have shown promise of using different water-lifting technologies and irrigation management to support off-season vegetable, seed, and irrigated fodder production (Okwany and Schmitter, 2016[[43]](#footnote-44), Schmitter *et al*., 2016[[44]](#footnote-45)). Moreover, research has identified numerous constraints to expanding the use of irrigation technologies along the value chains. The heterogeneity of farmers and respective demographics influences the preferences for technologies and therefore the level of entrepreneurship. Barriers, which prevent smallholder farmers in Ghana and Mali from entering into or advancing along the value chains are highly contextual and vary within and between countries; some key identified challenges are: (i) insecurity of land tenure; (ii) lack of infrastructure (e.g. roads, access to electricity, well drilling); (iii) limited access to irrigation technologies and/or credit; (iv) lack of after-sale services (e.g. maintenance, spare parts); (v) lack of reliable markets (both in terms of the crop value chains and the technology supply chains), (vi) inadequate or poorly maintained irrigation infrastructure and (vii) changing demographics of people in agriculture (women and shortage of labor) (Nakawuka et al., 2018[[45]](#footnote-46); Merry and Lefore, 2018[[46]](#footnote-47); Lefore et al., 2019[[47]](#footnote-48)).    A systemic approach to the scaling of irrigation technology and water management solutions to enhance value chain functionality is needed through addressing these systemic barriers. The systemic scaling approach helps to explore sustainable pathways to scaling so that irrigation technologies can better support sustainable intensification of household production systems, development of agricultural value chains, and resilience of food systems. To support systemic scaling of irrigation solutions for sustainable intensification, it is essential to conduct an enabling environment assessment to understand enablers and hinderers influencing farmers’ adoption of the technologies, so that measures are put in place to ensure success. Currently, IWMI is implementing several related initiatives on the **systemic scaling of small-scale irrigation (SSI) in Ghana**. Systemic scaling includes (1) water suitability/accounting, (2) enabling environment assessment, (3) co-identification of value chain scaling pathway, and (4) multi-stakeholder dialogues. These researches have been conducted under the scope of Africa Rising (Ethiopia), TAAT and ILSSI projects.  In **Ghana**, under the scope of the TAAT project, the enabling environment assessment is being conducted to understand enablers and hinderers influencing farmers’ adoption of the irrigation technologies, so that measures are put in place to ensure successful scaling of irrigation; while the ILSSI project works on water suitability and accounting. However, for scaling pathways to be gender and socially inclusive it is important to understand who participates and who benefits. This requires a contextualization of the scaling framework which captures not only the agricultural value chains but also the micro and macro environments of households, decision-making powers, and understanding of the entry points for women and youth along irrigated agricultural value chains at a local level. IWMI, therefore, proposes to develop contextually relevant inclusive scaling pathways by addressing the barriers for women and youth to partake in irrigated agricultural value chains in **Ghana**.  The scaling pathways through an enabling environment lens for irrigated agricultural value chains is a set of policies, informal institutions, support services, and other conditions that create or improve gender and social inclusion and maintain a general operational environment, bringing together value chain actors in a cooperative manner. Understanding such micro and macro environments of households and value chains as well as its influence on the scaling of irrigation technologies is important when catalyzing the appropriate enabling environment for integration and scaling of the irrigation technology and water solutions in sustainable manners (Lefore et al., 2019, see previous footnote). | | | | | | | | |
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| 2. Objectives | | | | | | | | |
| 2.1. Identify factors that enable the inclusion of women and youth along the irrigated vegetable value chain, especially in the output and input markets for irrigated vegetable production | | | | | | | | |
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| 3. Research questions | | | | | | | | |
| 3.1. What characterizes the enabling environment that facilitates the participation of farm families, and enables the inclusion of women and youth along irrigated vegetable value chains? | | | | | | | | |
|  | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | |
| The sub-activity is embedded in the action research outlined under the proposed systemic scaling pathway analysis in outcome 3.2 (GH3211-20).  The policy framework and intervention analysis will involve a review of policy clusters that influence the scaling of irrigation technologies and irrigated vegetable value chain development. The analysis will proceed in six steps, namely: (i) development of an inventory of relevant and existing policy/intervention documents, (ii) individual policy/intervention analysis, (iii) policy/intervention cluster analysis, (iv) cross-cluster analysis, (iv) overall analysis, and (v) validation of results.  The results from the policy framework and invention analysis will be consolidated through a synthesis analysis. The synthesis analysis will first characterize the enabling environment for scaling irrigation technologies and irrigated vegetable value chain development by reflecting on the results from analyses of policies and interventions, and draw inferences on:   * achievements and shortcomings in the technology scaling and irrigated vegetable value chain development; * alternative scenarios/solutions/models/approaches that could have addressed the shortcomings/constraints better; and * produce specific policy and implementation recommendations. | | | | | | | | |
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| 5. Data to be collected and uploaded on Dataverse | | | | | | Responsibility | | |
| * Policy framework with different policy clusters including socio-economic development framework, rural and agricultural development, social and gender inclusion, irrigation and water resources management, vegetable production, private sector development, etc. Objectives, target areas and beneficiaries, implementation strategies and mechanisms, institutional arrangements, changes in policy framework, conflicts, gaps, shortcomings * Enabling and disenabling factors to farmers’ participation in the irrigated vegetable value chain, drivers, and potentials solutions/recommendations * Interventions that support farmers’ participation and enable the inclusion of women and youth along irrigated vegetable value chains | | | | | | IWMI | | |
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| 6. Milestones | | | | | | | | |
| Deliverables | | | Means of verification | | | End date | | |
| 6.1 Database and qualitative dataset on enabling environment facilitating the scaling of irrigation and water solutions | | | Dataverse | | | Jun. 2022 | | |
| 6.2 Report on enabling factors facilitating the inclusion of women and youth along the irrigated vegetable value chain, especially in the output and input markets for irrigated vegetable production in Ghana | | | Progress and final report submitted to IITA | | | Dec. 2021 | | |
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| 7. Sustainable intensification indicators | | | | | | | | |
| Domain | Indicator | Metrics/  Scale | Approach used | | Before intervention | | | After intervention |
| 7.1 Productivity |  |  |  | |  | | |  |
| 7.2 Environmental |  |  |  | |  | | |  |
| 7.3 Economic |  |  |  | |  | | |  |
| 7.4 Social | Collective action | Participation in a collective action group or a social group  Capacity of group | Key Informant Interviews;  Focus group discussion | |  | | |  |
| 7.5 Human |  |  |  | |  | | |  |

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| 8. How will scaling be achieved? |
| Scaling will be achieved by a series of stakeholder engagement and system scaling activities, including, but not limited to:   * Using co-generation of knowledge through on-farm demonstration to scale-out innovative technologies; * Organizing stakeholder meetings with farmers and extension officers on the results of the trials and the preferred water lifting and application methods during the dry season * Sharing research results and engaging with potential scaling partners such as regional offices of Ministry of Food & Agriculture (MoFA) and GIDA (Ghana Irrigation Development Authority), the Agriculture Sector Working Group (ASWG) once the technologies and scaling pathways are co-identified and verified * Linking AR’s irrigation technology and value chain-based scaling pilots with relevant multi-stakeholder dialogues/platforms to integrate the scaling into the platforms’ agendas and to facilitate the systemic changes and capacity to enhance the scaling of irrigation technologies and water solutions * Developing and using fact sheets, workshops, policy briefs, as well as scientific papers to communicate to the wider public actors, practitioners, and relevant stakeholders |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| This sub-activity experiment is linked to scaling research conducted by IWMI for small-scale irrigation technology to support farmer-led irrigation expansion. In addition, it is linked to sub-activities planned by the World Vegetable Centre under GH11.15-21 and GH1116-21. And by STEPRI on policy and institutional analysis. The outcomes of this research will help to identify opportunities to scale bunghroo, solar-based pumping, and drip irrigation in isolation or combination to support irrigated vegetable production in the Upper East Region of Ghana and other similar areas in Ghana and beyond. |
|  |
| 10. Custom indicators |
| * Number of demonstrations established: N/A * Number of farmers trained: N/A * Number of field days organized: N/A * Number of meetings/workshops attended: N/A * Number of project reports produced: 01 technical report submitted * 1 journal article submitted/published |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  This sub-activity will address the following major development challenges   * highly vulnerable to the effects of climate change, while farmers are cultivating in marginal lands with low and erratic and are exposed to more frequent and longer dry spells and floods that threaten food security * Social and gender norms hindering social inclusion, together with limitation in the physical environment obstruct the investment and expansion of irrigation * Along the agricultural value chain, constraints to smallholders’ access to water management technologies and equipment as well as investment to irrigation include, but not limited to, under-developed irrigation value chains and capacities, under-developed irrigation supply chain, limited access to finance, energy, knowledge services to invest in irrigation, and weak input and output market linkages * Government policies and programs are biased towards large-scale irrigation and production system and lag behind efforts of smallholder farmers and the private sector in AWM   11.2 Who is your target audience, e.g. extension agents, farmers, or policymakers?  The most important audience includes small-scale farmers, women, and youth involved in farming, extension and development agents, policymakers, and the private sector who are working on irrigation and solar-powered products. |

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| 12. Budget | Ghana |
| Personnel |  |
| Services | 8,067 |
| Supplies | 0 |
| Capital | 0 |
| Travel | 0 |
| Overhead (17%) | 1,533 |
| Total | 9,599 |

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| 13. Gantt chart | | | | | | | |
| Year/ month | 2021 | | | | 2022 | | |
| Sep | Oct | Nov | Dec | Jan | Feb | Mar |
| Policy framework analysis |  |  |  |  |  |  |  |
| Irrigation and irrigated value chain intervention analysis |  |  |  |  |  |  |  |
| Reflection, data analysis and report writing |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 3: GH3121-21** | | | | | | | | | | | |
| Outcome 3: Farmers and other value chain actors have greater and equitable access to production assets and markets (input and output) through enabling institutions and policies | | | | | | | | | | | |
| a. Output 3.1 | | Enabling policies and institutional arrangements to increase participation of farm families, especially women and youth in the output and input markets and decision-making are advocated for implementation by national governments, policymakers and development partners | | | | | | | | | |
| b. Activity 3.1.2 | | Assess the level of inclusiveness of women and the youth along the crop and livestock value chains | | | | | | | | | |
| c. Sub-activity GH3121-21 | | Assessing the inclusiveness of women and youth within the vegetable production value chain to enhance vegetable production among smallholder farmers | | | | | | | | | |
|  | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | |
| Name | | Institution | | | | | Role | | | | |
| Jean Baptiste Tignegre | | WorldVeg | | | | | Sub-activity leader and activity coordination | | | | |
| Fred Kizito | | IITA | | | | | Hosts and advises WorldVeg team in Ghana | | | | |
| Thai Minh | | IWMI | | | | | Providing support to collect information for higher-level synthesis | | | | |
| Felix Badolo | | ICRISAT | | | | | Supervising fieldwork and collecting data | | | | |
| Benoit Gohevi | | ICRISAT | | | | | Leading the implementation of surveys, Developing data collection tools, training the research team on Feed the Future indicators | | | | |
| District Director of Agriculture | | MoFA, Department of Agriculture | | | | | Helping link the various actors and increasing their access to technologies and information | | | | |
| Benedict Ebito Boyubie | | IITA | | | | | Developing data collection tools, training the research team on Feed the Future indicators, and supporting data collection to track output level and Feed the future indicators,  Ensuring data upload on Dataverse | | | | |
| District Director of Agriculture | | DNA, Department of Agriculture | | | | | Helping link the various actors and increasing their access to technologies and information | | | | |
|  | |  | | | | |  | | | | |
| e. Student (s) | | | | | | | | | | | |
| Name | | Institute | | | |  | | |  | |  |
| NIL | |  | | | |  | | |  | |  |
|  | |  | | | |  | | |  | |  |
| f. Location(s) | | 1. UER (Duko, Tamale)  2. NR (Bonia, Niangua, Tekuru)  3. UWR (Wa) | | | | | | | | | |
|  | |  | | | | | | | | | |
| g. Start | | October 2021 | | | | | | | | | |
|  | |  | | | | | | | | | |
| h. End | | July 2022 | | | | | | | | | |
|  | |  | | | | | | | | | |
| 1. Justification | | | | | | | | | | | |
| This activity was conducted in 2021 in Ghana and will be carried forward into 2021-2022. Vegetable value chain strengthening is an effective instrument to fight gender inequality by expanding producers’ incomes and achieving a more balanced value-added appropriation for women and youth. Different stakeholders identified in 2021 in Ghana within the vegetable value chain participated in surveys. Among the participants were representatives from the Ministry of Food and Agriculture, Metropolitan assembly, Agro inputs, and agro machinery dealers, the University for Development Studies, Bolgatanga Technical University, Vegetable marketers and trader’s association, Women in Agriculture development, private organizations, Tractor operator’s union, Financial institutions, and smallholder farmers. As a result, the vegetable seed system is weak compared to that of the cereals. Women are more represented in the sector of processing (80%) while the youth are mostly seen in the sector of production (80%). A network of actors was successfully mapped during the meeting with roles assigned to each actor to ensure the sustainability of the chain that has been developed. It is therefore imperative to follow up to see whether these challenges were addressed by the stakeholders one year after the 2021 stakeholders’ meeting. | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | |
| 2.1 Evaluate the sustainability of linkages created in 2021 between women and young vegetable farmers in the value chain based on the dynamism of the innovation platform | | | | | | | | | | | |
| 2.2 Assess how well the local partnership between seed regulators and seed cooperatives/enterprises to register and produce seeds of farmers’ preferred varieties derived from the Africa RISING project is functional. | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 3. Research questions/hypotheses | | | | | | | | | | | |
| 3.1 Can women and youth be encouraged as seed producers (out-growers for seed enterprises) to participate actively in the seeds and inputs value chain through enabling policies? | | | | | | | | | | | |
| 3.2 How will the linkages between smallholder vegetable farmers and key seed and other inputs value chain actors be created or strengthened and how will sustainable linkages be created? | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | |
| Community forums will be organized at the community level to determine the dynamism of the platform for smallholder vegetable farmers and key actors in the vegetable value chain to dialogue and progress made towards reducing the constraints. | | | | | | | | | | | |
|  | | | | | |  | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | Responsibility/Institution | | | | | |
| Are the collected data part of a multi-year experiment/trial? Yes | | | | | | WorldVeg | | | | | |
| 5.1 Survey data on various key actors and constraints in the vegetable value chain | | | | | | Tignegre/WorldVeg | | | | | |
|  | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | |
| Deliverables | | | | Means of verification | | | | | | Delivery date | |
| Reports on linkages created (contracts formalized) | | | | Project report showing number of contracts and quantity of seed delivered (i) by seed enterprises and agro-dealers to beneficiaries, (ii) by female and young out-growers to seed enterprises (iii) under supervision or involvement of ARI, MoFA (DoA) & NGOs | | | | | | Feb. 2022 | |
| Community forums organized | | | | technical reports to IITA | | | | | | Feb. 2022 | |
| Manuals for seed production, water, and fertilizer management (brochures, leaflets, etc.) | | | | Project reports with number of documents distributed on seed transactions, water and fertilizer management regimes | | | | | | Feb. 2022 | |
| Update report on women and youth involved in seed and inputs value chain through seed production of key vegetable species | | | | Technical Report to IITA; contracts | | | | | | May 2022 | |
| Knowledge and information sharing forum | | | | Forum evaluation forms | | | | | | Jun. 2022 | |
| Contribute to the WA handbook | | | | Submitted and approved by chief scientist | | | | | | Throughout the year | |
|  | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | |
| Domain | Indicator | | Metrics/Scale | | Approach  For data collection | | | Before Intervention | | After Intervention | |
| 7.1 Social | Gender equity | | Equal Access to information and knowledge within seed and other inputs value chain at household level | | Group discussions, Forums | | | Limited access to seed & other inputs value chain information- No seed and other inputs order previously planned | | A platform of actors delivering information,  Number of contract seed farming formalized | |
| 7.2 Economic | Market participation,  Market orientation | | % production sold,  % land under cash crops  at household level | | Group discussions; Forums | | | % production sold and % land covered with cash crops at household before intervention | | % production sold and % land covered with cash crops at household level after intervention | |
|  |  | |  | |  | | |  | |  | |
| 8. How will scaling be achieved? | | | | | | | | | | | |
| Scaling will be done through the involvement of the MoFA, Women in Agriculture Associations, key-value chain actors, and other NGOs. Farmers will be linked to credit institutions and Village Savings and Loans Associations where they can contribute to and access credit to facilitate production | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 9. How are the activities in this protocol linked to those of others? | | | | | | | | | | | |
| This activity is also linked to the nutrition sub-activity GH2121-21: Container gardening training combined with nutrition education for increased vegetable consumption; GHGH1115-21, GH1116-21. | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 10. Custom indicators | | | | | | | | | | | |
| 10.1 105 value chain actors adhere to the innovation platform (35 in each UER, UWR and NR) | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 11. Impact-based summary matrix | | | | | | | | | | | |
| 11.1 What is the development challenge you are addressing?  The weak relationship between smallholder vegetable farmers and key actors in the vegetable value chain within the Northern sector of Ghana | | | | | | | | | | | |

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| 1. Budget | |
| Budget Line | WorldVeg |
| Personnel | 6,000 |
| Services | 5,000 |
| Supplies | 2,000 |
| Capital | 0 |
| Travel | 5,000 |
| Overhead (18.2%) | 3,276 |
| Total | 21,276 |

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| 13. Gantt chart | | | | | | | | |
| Year/ month | 2022 | | | | | | | |
| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
| Linkages created (contracts formalized for seed delivery (i) by seed enterprises and agro-dealers to beneficiaries, (ii) by out-growers to seed enterprises (iii) under supervision or involvement of DNA, UN Women and NGOs |  |  |  |  |  |  |  |  |
| Community forums organized |  |  |  |  |  |  |  |  |
| Women and youth involved in seed & inputs value chain through seed production of key vegetable species |  |  |  |  |  |  |  |  |
| Knowledge and information shared |  |  |  |  |  |  |  |  |
| Final report submission and data upload in Dataverse |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 3: GH3122-21** | | | | | | | | | | | | | |
| Outcome 3: Farmers and other value chain actors have greater and equitable access to production assets and markets (input and output) through enabling institutions and policies | | | | | | | | | | | | | |
| a. Output 3.1 | | | Output 3.1: Enabling policies and institutional arrangements to increase participation of farm families, especially women and youth in the output and input markets and decision-making are advocated for implementation by national governments, policymakers and development partners | | | | | | | | | | |
| b. Activity 3.1.2 | | | Assess the level of inclusiveness of women and the youth along crops and livestock value chains | | | | | | | | | | |
| c. Sub-activity GH3122-21 | | | Assess women and the youth participation in maize and small ruminant value chains in project communities and markets which the communities are linked to | | | | | | | | | | |
|  | | |  | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | |
| Name | | | | | Institution | | | Role | | | | | |
| Gundula Fischer | | | | | IITA | | | Social scientist, activity leader, development of tools and data analysis | | | | | |
| Kipo Jimah | | | | | IITA | | | Gender specialist, development of tools, data collection, and data analysis | | | | | |
|  | | | | |  | | |  | | | | | |
|  | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | Degree | | Start | End | |
| NIL | | | |  | | | | |  | |  |  | |
|  | | | | | | | | | | | | | |
| f. Location(s) | Northern Region for livestock value chain and Upper West Region for maize value chain | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | |
| g. Start | September 2021 | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | |
| h. End | June 2022 | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | |
| In Africa RISING’s second phase, research on post-harvest activities and value addition in Northern Ghana has been promoted[[48]](#footnote-49). Adopting a value chain approach, a clear understanding of the actors in crops and livestock systems is needed, especially in terms of their roles and relationships and the distribution of benefits from value chain participation. Such an understanding guides policymakers in developing strategies to improve rural livelihoods.  As Africa RISING continues to support farmers to increase agricultural production through technologies, it becomes more essential to engage in value chain analysis and to combine it with a gender perspective[[49]](#footnote-50). Available studies from Northern Ghana document differential gender roles in livestock production and ownership (Ansah and Nagbila 2011; Ansah et al., 2015; Baah et al., 2012)[[50]](#footnote-51), but lack an in-depth gender analysis and additional data from non-production actors (traders, veterinarians, etc.). For the maize value chain, there is little evidence with a gender focus, except for a study by Farnworth and Mahama (2012)[[51]](#footnote-52). The suggested sub-activity addressed the outlined gap and investigates gender and intergenerational relations in the maize and livestock value chains in communities in which Africa RISING is active and in the markets the communities are linked to.  The sub-activity is connected to previous and new gender studies. In 2019, a gender evaluation of the maize cowpea living mulch and maize leaf stripping interventions was conducted. Results provided insights into intra-household decision-making and labor allocation; access to resources as well as benefit-sharing among male and female household members. The results relate to the production node of the value chains. Beyond the production stage, research is ongoing on maize shelling machines introduced to farmer groups. In terms of new research, new gender investigations are planned for fertilizer (maize) and fodder cultivation (livestock). All of these studies have a technology focus and will be used not only to analyze relations in the value chains but also to ask what Africa RISING technologies can potentially contribute to value chain actors’ livelihoods. To answer this question men and women respondents from processing and trade will have to be added.  The Africa RISING baseline report (ARBES) shows that maize is the most dominant crop cultivated by farmers in the project target area, the main four crops being maize, rice, groundnut, and beans. 91% of the households in the project area cultivate maize with 74% of the production allocated to own consumption, 11% allocated to sale, 6% saved as seeds, and 9% used as a means of exchange. In the case of livestock, poultry is raised in 90% of the households. 72% keep local goats and 48% keep sheep[[52]](#footnote-53). For this reason, the proposed research will focus on the maize and small ruminant value chains. The research will adopt both quantitative and qualitative approaches to assess the level of inclusiveness of women and the youth in maize and small ruminant value chains and to reveal the effects of social norms that create inequalities within and across the two value chains.  The livestock study focused on the Northern Region. All livestock data have been collected and processed for analysis. The maize study (to be implemented in the Upper West) has not yet been completed. Data from a maize sheller survey (GH2212-20) were analyzed. Results of the maize sheller survey inform tool development for the maize value chain data collection that will be completed in December 2021 followed by data processing and write-up of findings. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | |
| 2.1 To assess women, men, and youth participation in and benefits from maize and small ruminant value chain activities in the project communities | | | | | | | | | | | | | |
| 2.2 To capture social norms and institutions that promote or hinder equitable value chain participation and benefits | | | | | | | | | | | | | |
| 2.2 To inform discussions and decisions on gender-responsive strategies and practices that will facilitate and increase the inclusiveness of women and the youth in maize and small ruminant value chains | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | |
| 3.1 What are the differential labor roles, benefits, and entry requirements for women and men (including age differences) concerning the maize and small ruminant value chains? | | | | | | | | | | | | | |
| 3.2 What are the inequitable social norms and institutions that could be addressed by gender-transformative approaches? | | | | | | | | | | | | | |
| 3.3 What will facilitate women and the youth participation in maize and small ruminants value chains? | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | |
| The study will use both qualitative and quantitative methods. A gendered value chain appraisal tool developed by Mutua et al. (2014)[[53]](#footnote-54) for focus group discussions will be combined with a gender transformative approach (Kruijssen et al. 2016)[[54]](#footnote-55) and a short concomitant survey. As the livestock value chain data collection in the Northern Region is complete, data collection will focus on the maize value chain in the Upper West Region. We will conduct 8 FGDs (4 with women, 4 with men) comprising of maize sheller and fertilizer trial farmers. We will also hold individual interviews with actors in the maize value chain. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded | | | | | | | | | | | | | Responsibility |
| 5.1 Quantitative data collected and uploaded to Dataverse | | | | | | | | | | | | | IITA |
|  | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | End date | | |
| 6.1 Clean mixed methods data files for analysis | | | | | | | Transcriptions and excel files | | | | Feb. 2022 | | |
| 6.2 Recommendations for gender-transformative value chain interventions | | | | | | | Brief on CGSpace | | | | Jun. 2022 | | |
| 6.3 Contribution to the WA handbook’s | | | | | | | Chapter submitted and approved by chief scientist’s | | | | Throughout the year | | |
|  | | | | | | |  | | | |  | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | |
| Domain | | Indicator | | | | Metrics/  Scale | Approach  Used In Data Collection | | | Before Intervention | | After Intervention | |
| 7.1 Productivity | |  | | | |  |  | | |  | |  | |
| 7.2 Environmental | |  | | | |  |  | | |  | |  | |
| 7.3 Economic | |  | | | |  |  | | |  | |  | |
| 7.4 Social | | * Market participation * Income * Labor | | | | * Household * Market | * Survey * FGDs * Participatory exercises (gender norms) | | | Not applicable | | Not applicable | |
| 7.5 Human | |  | | | |  |  | | |  | |  | |

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| 8. How will scaling be achieved? |
| The findings of the study will inform discussions and decisions on gender-responsive strategies and practices to be chosen for value chain interventions. The results of these processes will be communicated to development partners for further use. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| The activity in this protocol is linked to activities under outcome 3, improved policies, and institutional arrangements to increase farm family participation, especially women and youth in the output and input markets  This study links to the following other work plan activities (see above):   * Work plan Addah Wesseh leaf stripping (GH1123-21) * Work plan Terry Ansah fodder cultivation (GH1113-21) * Work plan Ayantunde Augustine feed troughs (GH1121-21) * Work plan Bekele Kotu maize shellers (GH2212-21) * Work plan Nurudeen Abdul Rahman fertilizer (GH1112-21) |
|  |
| 10. Custom indicators |
| 10.1 Recommendations for gender-transformative interventions in maize and small ruminants value chains in northern Ghana |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  Women and the youth play important roles in all stages of crops and livestock value chains. However, because they are largely not household heads, their contribution as well as enjoying the benefits of participating in value chains is limited. The study will provide an understanding of the roles, responsibilities, and relationships between women, men (including young men and women) in maize and small ruminants value chains, and the distribution of the benefits of engaging in maize and small ruminants which is crucial for policymakers in developing strategies to improve rural livelihoods. |
| 11.2 Who is your target audience, e.g., extension agents, farmers, or policymakers?  Farmers, traders, extension agents, policymakers, development actors. |

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| 12. Budget (US$) |  |
| Budget Line | IITA |
| Personnel | 4,520 |
| Services (including training of enumerators) | 413 |
| Supplies | 650 |
| Capital |  |
| Travel | 1,237 |
| Overhead |  |
| Total | 6,820 |

13. Gantt Chart

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Year/ month | 2021 | | | | 2022 | | | | | |
| Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
| Data collection/processing |  |  |  |  |  |  |  |  |  |  |
| Data analysis |  |  |  |  |  |  |  |  |  |  |
| M&E for verification |  |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 3: GH3122-21** | | | | | | | | | | | | | |
| Outcome 3: Farmers and other value chain actors have greater and equitable access to production assets and markets (input and output) through enabling institutions and policies | | | | | | | | | | | | | |
| Output 3.2 | | Options to expand accessibility of production assets and increase participation in household decision-making by disaggregated groups by gender | | | | | | | | | | | |
| 1. Activity 3.2.1 | | Identify constraints and opportunities for increasing women and youth access to production assets in the target area | | | | | | | | | | | |
| 1. Sub-activity: GH3212-21 | | Co-identify value chain-based scaling pathways for irrigation technologies and water solutions with farmers and other actors of vegetable value chains in the Africa RISING sites in Ghana and link these sites and activities to ILSSI’s multi-stakeholder Dialogue Space on small scale irrigation in Ghana.  Additional work is going to be conducted on “Scaling of demand-supply linkages for solar-powered irrigation pumps and PAY-OWN to other regions in Ghana” | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | |
| Name | | | Institution | | Role | | | | | | | | |
| Thai Thi Minh | | | IWMI | | Project leader. The senior researcher will be responsible for the market segmentation, irrigated vegetable value chain analysis and facilitate the expansion of private-sector partner’s demand-supply scaling pathway for solar-powered irrigation pumps and PAY-OWN services in the Upper East Region | | | | | | | | |
| Abena Ofosu | | | IWMI | | The Research Officer will carry out the data collection on the market segmentation and value chain analysis as well as coordinate the stakeholder engagement and consultation workshop | | | | | | | | |
| Postdoc (TBD) | | | IWMI | | The Postdoc will develop the monitoring and evaluation framework and indicators to assess, carry out data collection and analysis on SI indicators mainly on social and human conditions to evaluate holistic sustainability of the interventions | | | | | | | | |
| Field Assistant - Desire Dickson | | | IWMI | | The Field Assistant will support the arrangement of data collection as well as the organization of stakeholder engagement, demand-supply linkage workshop, and field demonstration days | | | | | | | | |
| Benedict Boyubie | | | IITA | | Support towards meeting project M&E requirements and FtF indicators while ensuring data upload on Dataverse | | | | | | | | |
|  | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | |
| Name | | | Institute | | | | | Degree | | Start | | End | | |
| NIL | | |  | | | | |  | |  | |  | | |
|  | | | | | | | | | | | | | |
| f. Location(s) | | Northern Ghana | | | | | | | | | | | |
|  | |  | | | | | | | | | | | |
| g. Start | | October 2021 | | | | | | | | | | | |
|  | |  | | | | | | | | | | | |
| h. End | | July 2022 | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | |
| Often, farmer investment in irrigation depends on income from the sale of irrigated crops for re-investing in inputs (pumps, fertilizers, improved seeds, pesticides) and expanding the irrigated areas to raise productivity (Adela et al., 2019[[55]](#footnote-56); de Bont et al., 2019[[56]](#footnote-57) and 2019a[[57]](#footnote-58)). Irrigation technology supply and services as well as access to well-established and profitable output markets need to be well-aligned for farmers to see the value of investing in irrigation for their production system. Access to the output market for agricultural products is a major factor determining farmers’ adoption of irrigation technologies. Hence, the scaling of irrigation technologies and services needs to address systemic barriers and opportunities along agricultural value chains.  To support the value chain-based scaling of irrigation technologies and services, it is essential to analyze the irrigated agricultural value chain. In 2020/21 IWMI had carried out the analysis of irrigated vegetable value chain in the Upper East Region. The analysis resulted in the co-identification of the demand-supply linkages pathway for scaling solar-powered irrigation pumps and PAY-AS-YOU-OWN (PAY-OWN) in the Upper East Region. Farmers pay back the loans in installments, as the pump allows them to increase their incomes, in what is known as a PAY-OWN approach. Taking a step further, IWMI has established a scaling partnership with Pumptech Ghana to implement the demand-supply linkages pathway in the Upper East Region[[58]](#footnote-59). It yielded results of benefiting more than 500 farmers in the Upper East Region from access to solar-powered irrigation pumps and PAY-OWN services and information as well as the new investment from Pumptech Ghana into opening a new office in the region to target the regional market demands.  In 2021/2022, we propose to expand this innovation to other regions based on the demand from various stakeholders and the private sector partner - Pumptech. For this expansion to take place, IWMI will need to support the demand-supply linkages pathway with insights into the regional market and facilitation on connecting regional multi actors and stakeholders to the sale and service partner networks. This requires doing market segmentation and irrigated agricultural value chain analysis in the potential region for expansion, for example, Upper West Region. Further, it requires follow-up actions on organizing a series of demand-supply linkages workshops to establish the sale and service partner networks in the new region(s). The assessment of the scaling partnership’s impact is also required to draw lessons learned for further value chain-based scaling interventions. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | |
| 2.1. Carry out market segmentation for the solar-powered irrigation pumps and PAY-OWN services in the Upper West Region Ghana | | | | | | | | | | | | | |
| 2.2. Analyze irrigated vegetable value chain to identify potential actors and stakeholders for the sale and service partner networks in the Upper West Region. | | | | | | | | | | | | | |
| 2.3. Establish the sale and service partner networks to ensure farmers’ access to solar-powered irrigation pumps and PAY-OWN services provided by Pumptech | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | |
| 3.1. How can the expansion of the scaling partnership with the private sector be facilitated? | | | | | | | | | | | | | |
| 3.2. How can the impacts of the scaling partnership with the private sector be accessed by smallholder farmers? | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | |
| The same action research approach will be applied for these scaling research activities | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded | | | | | | | | | | | | | Responsibility |
| 5.1 Database and qualitative dataset on demand-supply linkages for solar-powered irrigation pumps and PAY-OWN in the Upper West Region   * Vegetable value chain’s actors, their roles, and their relationships in the chain * Activities carried out by actors * Private sector actors involved in supplying irrigation equipment and water solutions and inputs * Farmers’ production system and marketing channels and local collection/trading systems * Vegetable market structure, demand and supply, opportunities, and trends * Farmers’ irrigation technologies’ preferences, financial capital to invest and PAY-OWN options as well access to resources for production | | | | | | | | | | | | | IWMI |
| 5.2 Impact indicators collected for the demand-supply linkages partnership for scaling solar-powered irrigation pumps and PAY-OWN services  Business and development outcomes of the demand-supply linkage scaling partnership including for examples but not limited to:   * Sales data * Private sector partners’ financial investment * Farmers’ investment into solar-powered irrigation pumps * Farmers’ productivity and income increase from the irrigation investment | | | | | | | | | | | | | IWMI |
|  | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | |
| Deliverables | | | | | | Means of verification | | | | End date | | | |
| 6.1 Database and qualitative dataset on demand-supply linkages for solar-powered irrigation pumps and PAY-OWN in the Upper West Region | | | | | | Dataverse | | | | Apr. 2022 | | | |
| 6.2. Report on the impact of the demand-supply linkages for solar-powered irrigation pumps and PAY-OWN services in the Upper East and West Region Ghana | | | | | | Project report to be published in CG Space submitted to IITA | | | | Jul. 2022 | | | |
| 6.3 Contribution to WA handbook | | | | | | Contribution submitted and approved by chief scientist | | | | Throughout the year | | | |
|  | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | |
| Domain | Indicators | | | Metric & Scale | | | Approach used in data collection | | Before intervention | | After intervention | | |
| 7.1 Productivity |  | | |  | | |  | |  | |  | | |
| 7.2 Environmental |  | | |  | | |  | |  | |  | | |
| 7.3 Economic |  | | |  | | |  | |  | |  | | |
| 7.4 Social | Social cohesion | | | Participation in community activities  Level and reliability of social support | | | Key informant Interviews  Focus group discussion; consultation workshop | |  | |  | | |
| 7.5 Human | Collective action | | | Participation in collective action group | | |  | |  | |  | | |
|  | Capacity to experiment | | | # of new practices being tested | | | Interviews; Focus group discussion; consultation workshop | |  | |  | | |

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| 8. How will scaling be achieved? |
| This is already a scaling activity. Further scaling will be achieved by a series of stakeholder engagement and system scaling activities including but not limited to:   * Organizing stakeholder meetings value chain actors and stakeholders on the results, impacts, and lessons learned from the demand-supply linkages scaling pathways; * Research results and engaging with potential scaling partners such as regional offices of Ministry of Food & Agriculture (MoFA) and GIDA (Ghana Irrigation Development Authority), the Agriculture Sector Working Group (ASWG) once the technologies and scaling pathways are co-identified and verified; and * Facilitate private sector’s irrigation equipment distribution companies to target their investment and services to specific market segments for solar-powered irrigation pumps and services (Co-leveraging with ILSSI project |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| This sub-activity is linked to scaling research conducted by IWMI for small-scale irrigation technology to support farmer-led irrigation expansion. The outcomes of this research will help to identify opportunities to scale solar-based pumping to support irrigated vegetable production in the Upper West Region of Ghana and other similar areas in Ghana and beyond. Further, it will help to operationalize the adaptive scaling approach through the private sector partnership scaling pathway. |
|  |
| 10. Custom indicators   * Number of demonstrations: 0 * Number of farmers trained: 500 * Number of field days organized: 8 * Number of meetings/workshops attended/organized: 8 demand-supply linkages workshops organized * Number of project reports produced: 01 Report on demand-supply linkage scaling pathway impacts submitted to IITA * 1 article submitted |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  This sub-activity will address the following major development challenges:   * highly vulnerable to the effects of climate change, while farmers are cultivating in marginal lands with low and erratic and are exposed to more frequent and longer dry spells and floods that threaten food security. * Constraints to smallholders’ access to water management technologies and equipment * Along the agricultural value chain, constraints to smallholders’ access to water management technologies and equipment as well as investment to irrigation include, but not limited to, under-developed irrigation value chains and capacities, under-developed irrigation supply chain, limited access to finance, energy, knowledge services to invest in irrigation, and weak input and output market linkages; * Government policies and programs are biased towards large-scale irrigation and production system and lag behind efforts of smallholder farmers and the private sector in AWM. |
| 11.2 Who is your target audience, e.g. extension agents, farmers, or policymakers?  The most important audience includes small-scale farmers, women, and youth involved in farming, extension and development agents, policymakers, and the private sector who are working on irrigation and solar-powered products. |

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| 12. Budget (US$) | IWMI |
| Personnel | 30,200 |
| Services | 26,150 |
| Supplies | 4,000 |
| Capital |  |
| Travel | 4,700 |
| Overhead | 12,581 |
| Total | 77,631 |

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| 13. Gantt chart | | | | | | | | | | | | |
| Year/ Month | 2021 | | | | | 2022 | | | | | | |
| Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul |
| Market segmentation and irrigated vegetable value chain analysis in the Upper West Ghana |  |  |  |  |  |  |  |  |  |  |  |  |
| Establishment of sale and service partner networks |  |  |  |  |  |  |  |  |  |  |  |  |
| Reflection, data analysis, and report writing |  |  |  |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 3: GH3213-21** | | | | | | | | | | | | | | | |
| Outcome 3: Farmers and other value chain actors have greater and equitable access to production assets and markets (input and output) through enabling institutions and policies | | | | | | | | | | | | | | | |
| Output 3.2 | | | | Options to expand accessibility of production assets and increase participation in household decision-making by disaggregated groups by gender | | | | | | | | | | | |
| Activity 3.2.1 | | | | Identify constraints and opportunities for increasing women and youth access to production assets in the target area | | | | | | | | | | | |
| c. Sub-activity: GH3213-21 | | | | Sustainable agricultural intensification, resilience capacity, and food security among smallholder farmers | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | | |
| Name | | | | Institution | | | Role | | | | | | | | |
| Bekele Kotu | | | | IITA | | | Agricultural economist, research design, data analysis, and writing | | | | | | | | |
| Julius Manda | | | | IITA | | | Agricultural economist, research design, data analysis, and writing | | | | | | | | |
| Carlo Azzarri | | | | IFPRI | | | Agricultural economist, research design, paper revision | | | | | | | | |
| Oyinbo Oyakhilomen | | | | University Ahmadu Bello University | | | Agricultural economist/consultant, data processing and analysis | | | | | | | | |
| Abdul Rahman Nurudeen | | | | IITA | | | Agronomist, expert consultation, Ghana | | | | | | | | |
| Fred Kizito | | | | IITA | | | NRM scientist, expert consultation, Ghana | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | | |
| Name | | | Institute | | | Degree | | | | Start | | | | | End |
| NIL | | |  | | |  | | | |  | | | | |  |
|  | | | | | | | | | | | | | | | |
| f. Location(s) | | Ghana and Malawi | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| g. Start | | June 2021 | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| h. End | | September 2022 | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | | |
| Rural livelihoods function in an environment characterized by pervasive risks and uncertainties. Farm risks and uncertainties are mainly associated with weather-related shocks (such as erratic rainfall distribution and pest infestations), market-related shocks (such as unpredictable input and output prices due to malfunctioning markets), and political upheavals. Moreover, productivity is low in smallholder agriculture arising from the low application of modern inputs and farming techniques, degradation of farmlands, and lack of effective control of diseases and pests. The low productivity complemented with weak integration of smallholder farmers into markets, and a high degree of risks and uncertainties, adversely affect the welfare of rural households as revealed by chronic food insecurity, malnutrition, and poverty. The Africa RISING Program has been working with smallholder farmers in several countries of Africa (including Ghana and Malawi) since 2011 to improve their livelihoods and reduce poverty through sustainable agricultural intensification. The activities included developing and scaling of improved agricultural technologies such as improved seeds, good agronomic practices, and land management practices. The interventions are expected to improve farmers’ welfare in various ways. Specifically, they can sustainably increase productivity and income while enhancing farmers’ resilience to shocks thereby reducing food insecurity and poverty. While livelihood improvements have already been revealed among the farmers, no systematic study has been conducted to examine the linkages between sustainable intensification, resilience capacity, and food security. This study aims to fill this gap. It assesses livelihood improvements through the lens of agricultural sustainability, resilience capacity, and food security conditions among farmers in cereal-legume systems of Ghana and Malawi. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | | |
| To evaluate the impacts of Africa RISING program intervention on sustainable intensification and resilience capacity and how this could improve the food security situation among the farm households. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | | |
| 3.1. Do smallholder farmers in Africa RISING intervention areas apply sustainable agricultural practices better than those farmers in non-intervention (control) areas? | | | | | | | | | | | | | | | |
| 3.2. Do smallholder farmers in Africa RISING intervention areas have more resilience capacity than those farmers in non-intervention (control) areas? | | | | | | | | | | | | | | | |
| 3.3. Does practicing sustainable intensification enhance food security among smallholder farmers? | | | | | | | | | | | | | | | |
| 3.4. Does better resilience capacity lead to better food security status among smallholder farmers? | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | | |
| The data for this study will come from Africa RISING baseline and end-line surveys in Ghana and Malawi. We will compute the sustainable intensification index using the max-min scaling approach at the household level considering SI domains as conceptualized in the Sustainable Intensification Assessment Framework (SIAF) (Musumba et al. 2017[[59]](#footnote-60)). This will be done once indicators for each domain are established. We will also compute a resilience index using the revised version of the Resilience Index Measurement and Analysis (RIMA-II) approach developed by FAO (d’Errico et al. 2018[[60]](#footnote-61)). As a robustness check, we will also employ other approaches to measure resilience (capacity) including the method proposed by Technical Assistant for NGOs (TANGO) International. We will use multiple indicators or a composite index depending on the suitability of the data. We will examine the linkages among the three factors (i.e. sustainable intensification, resilience capacity, and food security) using econometric models such as endogenous switching regression. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | | | Responsibility/Institute | | | |
| The study will be based on existing databases | | | | | | | | | | | | IFPRI, IITA | | | |
|  | | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | | |
| Deliverables | | | | | | | | Means of verification | | | | | Delivery date | | |
| 6.1. Technical report | | | | | | | | Link to online platforms (e.g CGSpace) | | | | | Apr. 2022 | | |
| 6.2. Journal article submitted for publication | | | | | | | | Notification from journal | | | | | Jun. 2022 | | |
| 6.3. Information brief shared with the wider audience | | | | | | | | Link to the online platform (AR website, CGSpace, etc.) | | | | | Jul. 2022 | | |
| 6.4. Webinar presentation | | | | | | | | Link to webinar slides | | | | | Aug. 2022 | | |
|  | | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | | |
| Domain | Indicator | | | | Metrics/Scale | | | | Approach used in data collection | | Before intervention | | | After intervention | |
| Productivity | Grain yield | | | | Output per hectare of land (t/ha) (scale, household level) | | | | The study will be based existing database | | Low maize yield (0.8t/ha-1.2t/ha) | | | High maize yield (25-50% higher than the baseline) | |
| Economic | Net income | | | | Net income per hectare ($/ha) (scale, household level) | | | | Low net income of farmer per unit of land | | | High net income per unit of land (50-100% higher than the baseline net income) | |
| Environment | Application of good agronomic practices including soil conservation practice (GAP) | | | | Proportion of land under maize on which GAP has been applied (%) (scale, household level) | | | | Low application of GAP (<10%) | | | High application of GAP (>50%) | |
| Human | Food security | | | | Indices such as number of meals in a day, dietary diversity score, experience of household food shortages (scale, household level) | | | | Low food security status | | | High food security status | |
| Social | Social network | | | | Membership in social organizations (scale, household as well as community level) | | | | Weak social network | | | Strong social network | |

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| 8. How will scaling be achieved? |
| This study focuses on the impact of Africa RISING intervention on sustainable intensification, resilience capacity, and food security among smallholder farmers. We hope that the results of the study will help the government and non-governmental development organizations in designing interventions that enhance sustainability and resilience among smallholder farmers thereby increasing welfare. To this effect, the implementing team intends to release an information brief and share it with various stakeholders. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| This is an ex-post analysis linking sustainable intensification, resilience capacity, and food security considering smallholder farmers cultivating maize as a case. It makes use of evidence generated from previous studies associated with maize which have been conducted within the Africa RISING program and beyond. |
|  |
| 10. Custom indicators |
| * Published paper in a peer-reviewed journal * Information brief with relevant recommendations |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  The Africa RISING project has been validating SI technologies on maize production and promoting their applications by smallholder farmers in Ghana and Malawi. The validated SI technologies range from soil enhancing and water conservation technologies such as ISFM, improved germplasm to improved postharvest technologies. Results based on these trials generally show that these technologies are essential in increasing the sustainability of maize-based cropping systems. However, no study has been done considering the wider population of smallholder farmers in Africa RISING intervention areas to justify their wider applications. While the goal of the Africa RISING program is to ensure a better welfare of smallholder farmers through sustainable agricultural intensification, studies linking sustainable intensification and household resilience capacity and food security are lacking. This study aims to generate empirical evidence towards filling this gap. |
| 11.2 Who is your target audience, e.g. extension agents, farmers, or policymakers?  Our study targets government and non-government organizations working on smallholder agriculture, agricultural researchers, and farmers. |

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| 12. Budget (US$) | |
| Budget line item | IITA |
| Personnel (casuals and consultants) | 7,000 |
| Services (publication fees) | 3,500 |
| Supplies | 500 |
| Capital |  |
| Travel |  |
| Overhead |  |
| Total | 12,000 |

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| Year/Month | 2021 | | | | 2022 | | | | | | | |
| Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
| Data organization and analysis |  |  |  |  |  |  |  |  |  |  |  |  |
| Drafting paper |  |  |  |  |  |  |  |  |  |  |  |  |
| Revising paper and submission to journal |  |  |  |  |  |  |  |  |  |  |  |  |
| Policy materials and seminar |  |  |  |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 4: GH4111-21** | | | | | | | | | | | | | | | |
| Outcome 4: Effective partnerships are built with farmers, local communities, and research and development partners in the private and public sectors to ensure delivery and uptake at scale of SI technologies, innovations, and practices | | | | | | | | | | | | | | | |
| a. Output 4.1 | | | Alliances and effective partnerships developed between farmers, local communities, and research and development agents in the public and private sectors to enable the release, dissemination, and adoption of proven technologies and practices to scale | | | | | | | | | | | | |
| b. Activity 4.1.1 | | | Conduct cost-benefit and gender analysis coupled with other socio-economic analyses to identify and quantify adoption constraints and opportunities for different farmer contexts | | | | | | | | | | | | |
| c. Sub-activity GH4111-21 | | | Conduct representative technological pathway analysis on adoption of technologies taking various socio-economic and biophysical dimensions into consideration | | | | | | | | | | | | |
|  | | |  | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | | |
| Name | | | | | | Institution | | | Role | | | | | | |
| Richard Ampadu-Ameyaw (Agricultural/Socio-Economist) | | | | | | CSIR-STEPRI | | | Lead (Research design, analysis, and reporting) | | | | | | |
| Nana Yamoah (Agricultural Economist) | | | | | | CSIR-STEPRI | | | Data analysis and reporting | | | | | | |
| Livingston Caesar (Business Management) | | | | | | CSIR-STEPRI | | | Data management and reporting | | | | | | |
| Emmanuel Tetteh Jumpah (Agricultural Economist) | | | | | | CSIR-STEPRI | | | Research design, data analysis and reporting | | | | | | |
| Benedict Boyubie | | | | | | IITA | | | FtF indicators and ensure data upload on DataVerse | | | | | | |
|  | | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | | Degree | | Start | End | | |
| NIL | | | |  | | | | | |  | |  |  | | |
|  | |  | | | | | | | | | | | | | |
| f. Location(s) | | Upper West, Upper East, Northeast, Northern, and Savannah Regions | | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | | |
| g. Start | | September 2019 | | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | | |
| h. End | | August 2022 | | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | | |
| The Africa RISING project is a key pathway towards better food security, improved livelihoods, and a healthy environment. Various technologies have been developed and validated by Africa RISING and STEPRI has been part of this effort. STEPRI has been involved in the implementation of activities that contribute mainly to Outcomes 3 and 4. So far, work has been done to analyze farmers’ access to input and output markets, delivery pathways for SI technologies and the role of government extension services, review of agricultural mechanization policy ordinances in Ghana, and simulation analysis on SI technology adoption. This sub-activity is a wrap-up effort to ensure that work that was started in 2019 can be represented in the form of Policy Briefs using the available past reports from STEPRI which will go a long way to address policy-related needs to enforce the work. The proposed four policy briefs are:   * Determinants of adoption potentials of smallholder farmers * Smallholder preferred markets (inputs and outputs) * Sustainable extension delivery pathways * Farm services and adoption potentials | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | | |
| 2.1 Develop policy briefs for previously conducted Africa RISING work on smallholder technologies to increase the visibility of sustainable intensification interventions through highlighting policy perspectives that can be used by the Agriculture Sector Working Group (ASWG) to further disseminate widely research findings | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | | |
| 3.1 What determines the adoption of SI technologies by smallholder farmers  3.2 Which are smallholder farmers preferred input and output markets?  3.3 What sustainable extension delivery pathways do exist for SI technologies?  3.4 What potentials do exit for better farm services to increase the potential for SI adoption? | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | | |
| Previous engagements included policy engagements/dialogues with stakeholders (MoFA, input dealers, traditional authorities, District Assemblies, RELC, Agricultural Sector Working Group, Peasant Farmers Association, etc.), and findings from these engagements will be synthesized to develop Policy Briefs that can help increase adoption of technologies. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded | | | | | | | | | | | | | | | Responsibility |
| Is the collected data part of a multi-year experiment/trial? Yes | | | | | | | | | | | | | | |  |
| 5.1 No new data will be collected. Only data drawn from previous work and secondary sources will be utilized such as data for representative pathway analysis, gender-related data, qualitative data from stakeholder policy engagement | | | | | | | | | | | | | | | STEPRI |
|  | | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | Delivery date | | | |
| 6.1 Four policy briefs as a summarized synthesis of previous work for increasing visibility and subsequent adoption of SI technologies | | | | | | | Technical reports submitted to IITA,  Policy Briefs uploaded on CG Space | | | | | Jul. 2022 | | | |
| 6.2 Knowledge sharing events at the community and district/regional levels | | | | | | | Knowledge sharing event reports fliers, leaflets  Media engagements | | | | | Jul. 2022 | | | |
| 6.3 Stakeholder policy engagement events and synthesis of the proceedings | | | | | | | Policy dialogue reports  Media briefs  Policy related contribution in West Africa Technology Handbook | | | | | Jun. 2022 | | | |
| 6.4 Journal article | | | | | | | Notification from journal about submission of manuscript | | | | | Jul. 2022 | | | |
| 6.5 Contributions to the WA handbook of technologies | | | | | | | Final contribution submitted and approved by the chief scientist | | | | | Jun. 2022 | | | |
|  | | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | | |
| Domain | Indicators | | | | Metric and scale | | | Approached used in data collection | | | Before intervention | | | After intervention | |
| 7.3 Economic | Profitability | | | | Profit and income at household level | | | Household survey | | | Low per capita and farm incomes | | | 73.1% of survey respondents indicated that adoption leads to improved incomes | |
| 7.4 Social | Social cohesion | | | | Collective action at community level | | | FGD, KII | | | Low social cohesion and gender equality (answer by 20.1% of survey respondents)  Exclusion of vulnerable groups | | | Improved social cohesion,  8.8% of vulnerable groups covered by the intervention | |
| 7.5 Human | Capacity to experiment and innovate | | | | Number of farmers experimenting with nutrition enhancing technologies at the household level | | | Household surveys, FGD | | | Members have low bargaining skills | | | Members have skills to opt for and use other market channels,  65.8% of survey respondents indicated applying improved agricultural practices | |

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| 8. How will scaling be achieved? |
| The findings of our study will benefit the Africa RISING communities, partners, and policymakers interested in promoting technology adoption and gender for inclusiveness, increased incomes, and productivity. It will highlight the impact of technological pathways relating to maize-cowpea intercropping, cowpea living mulch, the timing of fertilizer application, maize leaf stripping, and stimulate wider adoption of these technologies in the future. Results of the evidence-based research conducted on farmers’ access to markets and technology adoption simulation will be presented at the community and district levels. This will not only deepen the knowledge of local actors on what has been achieved by the Africa RISING project but will also highlight institutional barriers that local actors can ease for wider adoption and improved well-being of people in the communities. The results of this study will be presented and discussed at workshops, conferences, and policy dialogues for policymakers’ support. Available knowledge management platforms (such as FARA’s DataInformS) will be used to disseminate widely policy briefs, leaflets, fact sheets, etc. to inform different stakeholders about lessons learned from the intervention. A journal article will also be prepared and published. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| The proposed activity is directly linked to two other sub-activities (mainly within Outputs 1 and 2) being implemented under the Africa RISING program. First, it draws on the crops/productivity work being done by IITA -Sub-activity GH1111-20, and secondly on the crop/livestock activities being implemented by ILRI and ARI in northern Ghana through sub-activity GH3111-20. The activity also extends and builds on previous work done by STEPRI on market access and technology adoption simulation (Outcomes 3 and 4) by undertaking gender-disaggregated analysis using the available data to inform policy. Certainly, this is expected to enrich policy discussions and improve the decision-making of households regarding which technological pathways will likely yield positive impacts on their livelihoods. |
|  |
| 10. Custom indicators |
| * 17 community engagements and 8 policy dialogues/ workshops held * 1 technical leaflet, 3 fact sheets, and 2 policy briefs produced (printed and distributed by STEPRI) * Two journal articles submitted/published |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  In Ghana, the low adoption of modern agricultural production technologies amongst farmers has been identified as one of the main reasons for the low agricultural productivity. The factors that influence the adoption of modern agricultural production technologies are related to economic, social, and institutional factors. Increasingly, the adoption of technologies by farmers is on a growth trajectory among smallholder resource-poor farmers in northern Ghana. However, the impact pathways of these technologies and gender analysis to inform the adoption decisions for these technologies have not been adequately assessed. Food insecurity and low incomes, therefore, remain a challenge. Furthermore, research evidence gathered from farmers and other relevant stakeholders engaged in the crop and livestock value chains on market access and technology adoption through household surveys is yet to be shared with actors at the local level. As such, an information knowledge gap exists between researchers, project communities, and other key stakeholders. Through community engagements and other policy platforms, this sub-activity will facilitate the sharing of research findings for wider adoption, scaling, and practice for improved wellbeing. |

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| 12. Budget (US$) |  |
| Budget Item | STEPRI |
| Personnel | 15,000.00 |
| Services | 3,000.00 |
| Supplies | 2,000.00 |
| Capital\* | 18,000.00 |
| Travel | 4,000.00 |
| Overhead | 6,300.00 |
| Total | 48,300.00 |

\*Represents the majority of the costs for media engagement, policy dialogue, the printing of briefs for distribution, and so forth

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| --- | --- | --- | --- | --- | --- | --- | --- |
| 13. Gantt Chart | | | | | | | |
| Year/ Months | **2022** | | | | | | |
| Jan | Feb | Mar | Apr | May | Jun | Jul |
| Data extractions (socioeconomic, biophysical, gender) from varied sources |  |  |  |  |  |  |  |
| Data organization and analysis |  |  |  |  |  |  |  |
| Community/ district level engagements |  |  |  |  |  |  |  |
| Policy dialogues |  |  |  |  |  |  |  |
| M&E verification/ Data uploads |  |  |  |  |  |  |  |
| Working on Policy briefs |  |  |  |  |  |  |  |
| Report writing |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 4: GH4111-21** | | | | | | | | | | | | | | | |
| Outcome 4: Effective partnerships are built with farmers, local communities, and research and development partners in the private and public sectors to ensure delivery and uptake at scale of SI technologies, innovations, and practices | | | | | | | | | | | | | | | |
| a. Output 4.1 | | | | Alliances and effective partnerships developed between farmers, local communities, and research and development agents in the public and private sectors to enable the release, dissemination, and adoption of proven technologies and practices to scale | | | | | | | | | | | |
| b. Activity: 4.1.1 | | | | Conduct cost-benefit and gender analyses coupled with other socio-economic analyses to identify and quantify adoption constraints and opportunities for different farmer contexts | | | | | | | | | | | |
| c. Sub-activity GH 4112-21 | | | | Evaluate the impact of Africa RISING investments on the Return on Investment (ROI) | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | | |
| Name | | | | Institution | | | Role | | | | | | | | |
| Bekele Kotu | | | | IITA | | | Agricultural economist, research design, data analysis, and writing | | | | | | | | |
| Julius Manda | | | | IITA | | | Agricultural economist, research design, data analysis, and writing | | | | | | | | |
| Felix Badolo | | | | ICRISAT | | | Agricultural economist, research design, data analysis, and writing | | | | | | | | |
| Carlo Azzarri | | | | IFPRI | | | Agricultural economist, research design, paper revision | | | | | | | | |
| Oyinbo Oyakhilomen | | | | University Ahmadu Bello University | | | Agricultural economist/consultant, data processing and analysis | | | | | | | | |
| Abdul Rahman Nurudeen | | | | IITA | | | Agronomist, expert consultation on technology selection and data, Ghana | | | | | | | | |
| Elirehema Swai | | | | TARI | | | Agronomist, expert consultation on technology selection and data, Tanzania | | | | | | | | |
| Regis Chikowo | | | | MSU | | | Agronomist, expert consultation on technology selection and data, Malawi | | | | | | | | |
| Birhanu Zemadim | | | | ICRISAT | | | NRM scientist, expert consultation on technology selection and data, Mali | | | | | | | | |
| Fred Kizito | | | | IITA | | | NRM scientist, expert consultation on technology selection, Ghana | | | | | | | | |
| Bekunda Mateete | | | | IITA | | | NRM scientist, expert consultation on technology selection and data, Tanzania | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | | |
| Name | | | Institute | | | Degree | | | | Start | | | | | End |
| NIL | | |  | | |  | | | |  | | | | |  |
|  | | | | | | | | | | | | | | | |
| f. Location(s) | | Ghana, Malawi, Mali, and Tanzania | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| g. Start | | June 2021 | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| h. End | | June 2022 | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | | |
| Agricultural productivity growth has long been recognized as one of the most important and effective pathways through which agricultural research and technologies can increase rural incomes, food security and reduce poverty. To this end, the Africa RISING project has been testing, validating, and promoting improved technologies through sustainable intensification to increase agricultural productivity, food, and nutrition security, and reduce poverty. The AR project has led to the development and diffusion of improved agricultural technologies representing a major scientific and policy achievement in West Africa as well as East and Southern Africa. Despite these achievements, rigorous impact evaluation has not been done to investigate the return to investment (ROI) and household welfare as a result of the impact of these interventions.  The Africa RISING project has been validating SI technologies through farmer-managed on-farm trials in Ghana, Malawi, Mali, and Tanzania. The SI technologies which have been validated range from soil enhancing and water conservation technologies such ISFM and tied ridges respectively as well as improved germplasm (improved maize and legume varieties) to improved postharvest technologies. Results based on these trials generally show that these technologies are essential in increasing the productivity and profitability of maize and legume production. However, research focusing on assessing the potential economic impacts of these technologies beyond profitability is lacking. This study will evaluate the potential (ex-ante) impacts of selected Africa RISING technologies on ROI to guide further investments in research and extension.  Similarly, baseline and follow-up surveys have been done in Ghana and Malawi by IFPRI on Africa RISING beneficiaries and non-beneficiaries. To date, no study has been conducted to estimate the impact of the adoption of these technologies on ROI and indicators of household welfare such as household income, food security, and poverty. We focus on maize-legume strip cropping technology in Ghana. We have selected this technology because it has been promoted since 2014 and it lends itself for both ex-ante and ex-post analysis of ROI. We hope that by estimating the adoption effects on the selected outcome variables, we will follow and adapt earlier work in the vein by Asfaw, et al. (2009)[[61]](#footnote-62), Kleemann, et al.(2014)[[62]](#footnote-63), and Udry, et al.(2006[[63]](#footnote-64)). | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | | |
| 2.1 To examine the ex-ante impacts of Africa RISING investment on ROI in Ghana, Malawi, Mali, and Tanzania | | | | | | | | | | | | | | | |
| 2.2 To examine the ex-post impact of Africa RISING investment on ROI in Ghana and Malawi | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | | |
| 3.1. What is the potential impact of farming technologies promoted by Africa RISING on financial return on investment for the farmer who invests in them? | | | | | | | | | | | | | | | |
| 3.2. Have the farming technologies promoted by Africa RISING increased the financial return of smallholder farmers invested in the technologies? | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | | |
| The data for analysis will come from already conducted work from on-farm trials and demonstration plots conducted in Africa RISING intervention sites. Specifically, data on inputs, input costs, and productivity of selected Africa RISING technologies will be obtained from the Africa RISING scientists in Malawi, Ghana, and Tanzania. Coupled with this, the costs of investments will be obtained from the approved budgets from the AR project management and accounts. Moreover, data from the Africa RISING baseline and end-line surveys will be used.  To estimate the potential economic impacts of Africa RISING technologies, the Economic Surplus Model (ESM) will be used e.g. (Alene et al., 2009[[64]](#footnote-65); Alston et al., 1995[[65]](#footnote-66)). The method involves the generation of adoption estimates through previous households’ surveys on similar AR technologies and including these rates to estimate the impact on a range of outcome variables, including social welfare outcomes. Econometric models such as the endogenous switching regression model will be used for the ex-post analysis. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | | | Responsibility/Institute | | | |
| The study will be based on existing databases. | | | | | | | | | | | | IITA, ICRISAT | | | |
|  | | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | | |
| Deliverables | | | | | | | | Means of verification | | | | | Delivery date | | |
| 6.1. Technical report | | | | | | | | Link to online platforms (e.g., CGSpace) | | | | | Apr. 2022 | | |
| 6.2. Journal article submitted for publication | | | | | | | | Notification from journal | | | | | Apr. 2022 | | |
| 6.3. Information brief shared with the wider audience | | | | | | | | Link to the online platform (AR website, CGSpace, etc.) | | | | | Jun. 2022 | | |
| 6.4. Webinar presentation | | | | | | | | Link to webinar slides | | | | | Jul. 2022 | | |
|  | | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | | |
| Domain | Indicator | | | | Metrics/Scale | | | | Approach used in data collection | | Before intervention | | | After intervention | |
| Economic | Profitability | | | | Net income per hectare ($/ha) | | | | The study will be based existing database | | <1,000 Ghc of net income per hectare | | | >2,000 Ghc net income per hectare | |
|  | | | | | | | | | | | | | | | |

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| 8. How will scaling be achieved? |
| This study focuses on the impact of Africa RISING technologies on return on investment by smallholder farmers. We hope that the results of the study will help the government and non-governmental development organizations to prioritize technologies for scaling. To this effect, the implementing team intends to release an information brief and share it with various stakeholders including NARES, RELC, and other implementing partners. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| The study assesses the impact of Africa RISING technologies on returns to investment. Thus, it has direct links with all research activities associated with the technologies selected for analysis. |
|  |
| 10. Custom indicators |
| * Published paper in peer-reviewed journals and conference presentations * Information brief with relevant recommendations for targeting adoptable interventions |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  The Africa RISING project has been validating SI technologies through farmer-managed on-farm trials in Malawi, Ghana, Mali, and Tanzania. The SI technologies which have been validated range from soil enhancing and water conservation technologies such as ISFM, improved germplasm (improved maize and legume varieties) to improved postharvest technologies. Results based on these trials generally show that these technologies are essential in increasing the productivity and profitability of maize and legumes production. However, research focusing on assessing the potential economic impacts of these technologies is lacking. This study will evaluate the potential (ex-ante) impact of maize-legume striping practice on ROI to guide further investments in research and extension. |
| 11.2 Who is your target audience, e.g. extension agents, farmers, or policymakers?  Our study targets government and non-government organizations working on smallholder agriculture, agricultural researchers, and farmers. |

|  |  |
| --- | --- |
| 12. Budget (US$) | |
| Budget line item | IITA |
| Personnel (casuals and consultants) | 7,000 |
| Services (publication fees) | 3,500 |
| Supplies | 500 |
| Capital |  |
| Travel | 1,000 |
| Overhead |  |
| Total | 12,000 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 13. Gantt Chart | | | | | | | | | | |
| Year/Month | 2021 | | | | | | 2022 | | | |
| Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
| Data organization and analysis |  |  |  |  |  |  |  |  |  |  |
| Drafting paper |  |  |  |  |  |  |  |  |  |  |
| Revising paper and submission to journal |  |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 4: GH4113-21** | | | | | | | | | | | | | |
| Outcome 4: Effective partnerships are built with farmers, local communities, and research and development partners in the private and public sectors to ensure delivery and uptake at scale of SI technologies, innovations and practices | | | | | | | | | | | | | |
| a. Output 4.1 | | | Alliances and effective partnerships developed between farmers, local communities, and research and development agents in the public and private sectors to enable the release, dissemination, and adoption of proven technologies and practices to scale | | | | | | | | | | |
| b. Activity 4.1.1 | | | Map and assess relevant stakeholders to establish a dialogue for the exploration of mutual synergies for scaling delivery of validated technologies | | | | | | | | | | |
| c. Sub-activity GH4113-21 | | | Provide safety nets to smallholder farmers through crop insurance while developing a business model with multi-stakeholder partners for scaling validated technologies for equity and empowerment | | | | | | | | | | |
|  | | |  | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | |
| Name | | | | | Institution | | | | Role | | | | |
| Fred Kizito | | | | | IITA | | | | -Land and soil management support  - Link the Excellence in Agronomy initiative to Africa RISING efforts on crop calendar advisories in partnership with SEEDPAG and WorldCover. | | | | |
| Benedict Boyubie | | | | | IITA | | | | M&E and FtF Indicators support | | | | |
|  | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | | Degree | Start | End | |
|  | | | |  | | | | | |  |  |  | |
|  |  | | | | | | | | | | | | |
| f. Location(s) | Central Gonja, Karga, and Mion districts in Northern Region | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | |
| g. Start | June 2019 | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | |
| h. End | July 2022 | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | |
| Africa RISING has validated various technologies and has further provided linkage of smallholder farmers to strong partnership with private seed sector partners to increase and diversify their input sources while using improved seed and fertilizer. GAIP will continue to insure farmers against crop failure from disaster such as drought. Farmers use validated Africa RISING technologies in addition to the insurance policy to address risks associated with farming in the Africa RISING intervention communities.  A missing element to this work has been the development of an online tool allows us to record and track progress on different farmers that get in touch with the beneficiary groups and the nature of information and interventions shared. We will represent the bundles of adopted technologies in the online tool. On-going discussions with the M&E Officer will ensure that this initiative takes effect. A web-interface will be developed to ensure that this tool is accessible by private sector and donors. This will be the final deliverable for this | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | |
| 2.1. Explore the role of insurance in promoting uptake of agronomic interventions through linking with work being conducted in the EiA initiative | | | | | | | | | | | | | |
| 2.2. Develop an online web-interface accessible by private sector and donors that shows numbers of farmers reached, their current demography and the bundles of technologies adopted | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | |
| 3.1 How can we represent bundled services in farming communities through an online tool that can be accessible to donors and private sector as well as lead farmers? | | | | | | | | | | | | | |
| 3.2 How does building capacity of smallholder farmers promote uptake of validated technologies? | | | | | | | | | | | | | |
| 3.3 What is the role of insurance in promoting uptake of agronomic interventions? | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | |
| We are using an approach of Bundled Agronomy Services Kits for Enhancing Transformation (BASKETS) in agriculture. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded | | | | | | | | | | | Responsibility | | |
| 5.1 Grain yield of improved maize seeds | | | | | | | | | | | IITA | | |
| 5.2 Profitability of the business model | | | | | | | | | | | IITA | | |
| 5.3. Precision of predictions for seasonal calendar | | | | | | | | | | | WorldCover | | |
|  | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | End date | | |
| 6.1 Web-interface Tool | | | | | | | Link of Africa RISING wiki | | | | Mar. 2022 | | |
| 6.2 Datasets supporting interface tool | | | | | | | Dataverse | | | | June 2022 | | |
|  | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | |
| Domain | | Indicator | | | | Metrics/Scale | | Methods/Approaches taken including duration | | | Before intervention | | After intervention |
| 7.1 Productivity | | Crop productivity | | | | Crop productivity (kg/ha) at plot/ field and farm level | | Field yield measurement | | | Yield from farmer practice | | 20% increase in grain yield |
| 7.2 Environmental | |  | | | |  | |  | | |  | |  |
| 7.3 Economic | | Profitability | | | | Profitability of the business model (GHS/ha) at the plot/ field level | | Survey and yield measurement | | | Net income from farmer practice | | 15% increase in net income |

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| 8. How will scaling be achieved? |
| Scaling of the business model will be achieved through strategic partnership with development partners specifically GAIP and DEGAS. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| This activity is linked with crop-livestock research activities GH1112-20 and the natural resources management work being done in collaboration with KNUST- Sub-activity GH1212-20 |
|  |
| 10. Custom indicators |
| * Database on business model * Seed Production Training Reports |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  Food insecurity and natural resource management.  This sub-activity will address the following major development challenges. (I) food insecurity, (ii) increased productivity can also contribute to a profitable crop enterprise thereby improving household income. |
| 11.2 Who is your target audience, e.g., extension agents, farmers, or policymakers?  Farmers, extension agents, and policymakers |

12. Budget (US$)

|  |  |
| --- | --- |
| Budget Line | IITA |
| Personnel | 0 |
| Services | 12,000\* |
| Supplies | 4,000 |
| Capital | 4,000 |
| Travel | 3,000 |
| Overhead | 0 |
| Total | 23,000 |

\*The costs include hiring of a programmer and web-interface specialist for development of online tool. This will have a linkage to MWANGA platform as well.

13. Gantt Chart

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Year/Month** | **2022** | | | | | | |
| **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** |
| Farmer sensitization |  |  |  |  |  |  |  |
| Web interface tool development |  |  |  |  |  |  |  |
| Web tool validation |  |  |  |  |  |  |  |
| Semi-Annual Report |  |  |  |  |  |  |  |
| End of Project Community field days |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 4: GH4113-21** | | | | | | | | | | | | | | | |
| Outcome 4: Effective partnerships are built with farmers, local communities, and research and development partners in the private and public sectors to ensure delivery and uptake at scale of SI technologies, innovations and practices | | | | | | | | | | | | | | | |
| a. Output 4.1 | | | | Alliances and effective partnerships developed between farmers, local communities, and research and development agents in the public and private sectors to enable the release, dissemination, and adoption of proven technologies and practices to scale | | | | | | | | | | | |
| b. Activity: 4.1.1 | | | | Conduct cost-benefit and gender analyses coupled with other socio-economic analyses to identify and quantify adoption constraints and opportunities for different farmer contexts | | | | | | | | | | | |
| c. Sub-activity GH 4115-21 | | | | The impact of smallholder Agricultural commercialization on household income and nutrition in Ghana and Malawi | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | | |
| Name | | | | Institution | | | | Role | | | | | | | |
| Julius Manda | | | | IITA | | | | Agricultural economist, research design, data analysis, and writing | | | | | | | |
| Bekele Kotu | | | | IITA | | | | Agricultural economist, research design, data analysis, and writing | | | | | | | |
| Carlo Azzarri | | | | IFPRI | | | | Agricultural economist, research design, paper revision | | | | | | | |
| Shiferaw Feleke | | | | IITA | | | | Agricultural economist, research design, paper revision | | | | | | | |
| Oyinbo Oyakhilomen | | | | University Ahmadu Bello University | | | | Agricultural economist/consultant, data processing and analysis | | | | | | | |
|  | | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | | |
| Name | | | Institute | | | Degree | | | | Start | | | | | End |
| NIL | | |  | | |  | | | |  | | | | |  |
|  | | | | | | | | | | | | | | | |
| f. Location(s) | | Ghana and Malawi | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| g. Start | | June 2021 | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| h. End | | September 2022 | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | | |
| Agricultural productivity growth has long been recognized as one of the most important and effective pathways through which agricultural research and technologies can increase rural incomes, nutrition and reduce poverty (Gollin, Hansen, and Wingender, 2021)[[66]](#footnote-67). However, the link between agricultural research and nutrition is not straightforward as benefits may not be accrued uniformly across different income groups. Previous studies have shown that Agricultural commercialization is one of the pathways through which farmers can increase income and nutrition (Ogutu and Qaim, 2019[[67]](#footnote-68); Carletto et al., 2017[[68]](#footnote-69)). Commercialization will be measured based on farmers’ agricultural production and marketing activities using baseline and end-line survey data in Ghana and Tanzania. We will consider all crop and livestock enterprises of the farm household. Specifically, the level of household agricultural commercialization will be measured as the share of total farm output sold in the two-survey periods. Based on this definition, the process of agricultural commercialization can be represented by an index (CI) ranging from pure subsistence (CI = 0) to a completely commercialized production system (C1 = 100)[[69]](#footnote-70). Unlike the common binary measures of sellers versus non-sellers, or between staple and cash crop producers, this index also measures how much of the farm output households choose to sell. Considering the limited empirical evidence of the impact of agricultural commercialization on income and nutrition, this study aims to fill this gap based on a panel household survey data from Malawi and Ghana. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | | |
| 2.1 To examine how agricultural commercialization can increase smallholder household incomes and nutrition | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | | |
| 3.1. Does agricultural commercialization improve smallholder farmers’ income? | | | | | | | | | | | | | | | |
| 3.2. Does agricultural commercialization improve smallholder farmers’ nutrition status? | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | | |
| The data for this study will come from Africa RISING baseline and end-line surveys in Ghana and Malawi. We will apply innovative estimation methods to control for observed and unobserved characteristics that would otherwise bias our results. Specifically, we will use the correlated random effects (CRE) model to estimate the impact of commercialization on income and nutrition. The CRE estimator allows us to explicitly examine the effects of observable time-constant determinants by including a vector of time-averaged variables, which the fixed effects (FE) estimator cannot do (Wooldridge, 2010)[[70]](#footnote-71). Moreover, it allows for correlation between unobserved and observed factors, which the random effects (RE) estimator assumes to be zero (Burke et al., 2020[[71]](#footnote-72); Wooldridge, 2010). We will account for the observed covariates that are assumed to be exogenous [e.g., household demographics, policies, etc.) and endogenous [e.g., decision to sell, unobserved characteristics (e.g., innate managerial and technical abilities of the farmers in understanding and using productivity-enhancing agricultural technologies]. We will estimate our equations as follows:  First stage: Estimate the determinants of commercialization (dependent variable: CI) in which we will include a rich set of covariates to account for observed and unobserved characteristics. We control for unobserved characteristics using instrumental variables and a vector of time-averaged variables [ to control for time-constant unobserved heterogeneity]   1. Second stage: We estimate the impact of commercialization on income & nutrition using information obtained from the first stage. After doing this, we can now attach a causal interpretation to our results. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | | | Responsibility/Institute | | | |
| The study will be based on existing databases. | | | | | | | | | | | | IFPRI, IITA | | | |
|  | | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | | Delivery date | | |
| 6.1. Technical report | | | | | | | Link to online platforms (e.g CGSpace) | | | | | | Apr. 2022 | | |
| 6.2. Journal article submitted for publication | | | | | | | Notification from journal | | | | | | Jun. 2022 | | |
| 6.3. Information brief shared with the wider audience | | | | | | | Link to the online platform (AR website, CGSpace, etc.) | | | | | | Jul. 2022 | | |
| 6.4. Webinar presentation | | | | | | | Link to webinar slides | | | | | | Aug. 2022 | | |
|  | | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | | |
| Domain | Indicator | | | | Metrics/Scale | | | | Approach used in data collection | | Before intervention | | | After intervention | |
| Economic | * Level of output commercialization * Income from agricultural output sales | | | | * Proportion of output sold * Income per household (per capita) per year ($/ha) (scale, household level) | | | | The study uses existing data sets | | * Low level of commercialization (<20% sold) * Low income from sales of farm outputs | | | * High level of commercialization (>20% sold) * High income from sales of farm outputs (50% higher than the baseline) | |
| Human | Household nutrition status | | | | Dietary diversity score (scale, household level) | | | | Low dietary diversity (less than 6 food categories) | | | High dietary diversity (>6 food categories) | |

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| 8. How will scaling be achieved? |
| This study focuses on the impact of commercialization on the income and nutrition of smallholder farmers. We hope that the results of the study will help the government and non-governmental development organizations in designing interventions that improve income and nutrition thereby increasing welfare. To this effect, the implementing team intends to release an information brief and share it with various stakeholders. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| This is an ex-post analysis linking agricultural commercialization to household income and nutrition. It makes use of evidence generated from previous studies which have been conducted within the Africa RISING Program and beyond. |
|  |
| 10. Custom indicators |
| * Published paper in a peer-reviewed journal * Information brief with relevant recommendations |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  The Africa RISING project has been validating sustainable intensification (SI) technologies and promoting their applications by smallholder farmers in Ghana and Malawi. The SI technologies which have been validated range from soil enhancing and water conservation technologies such as ISFM, improved germplasm to improved postharvest technologies. Results based on these trials generally show that these technologies are essential in increasing income and nutrition among smallholder farmers. However, no study has been conducted considering the wider population of smallholder farmers in Africa RISING intervention areas to justify their wider applications. Moreover, the impact of the technologies on income and nutrition can be influenced by farmers' access to markets and their decision to engage in output commercialization. While the goal of the Africa RISING program is to ensure better welfare of smallholder farmers through sustainable agricultural intensification and improving farmers' access to markets, studies linking agricultural commercialization and household welfare are lacking. This study aims to generate empirical evidence towards filling this gap. |
| 11.2 Who is your target audience, e.g., extension agents, farmers, or policymakers?  Our study targets government and non-government organizations working on smallholder agriculture, agricultural researchers, and farmers. |

|  |  |
| --- | --- |
| 12. Budget (US$) | |
| Budget line item | IITA |
| Personnel (casuals and consultants) | 7,000 |
| Services (publication fees) | 3,500 |
| Supplies | 500 |
| Capital |  |
| Travel | 1,000 |
| Overhead |  |
| Total | 12,000 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Year/Month | 2021 | | | | 2022 | | | | | | | |
| Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
| Data organization and analysis |  |  |  |  |  |  |  |  |  |  |  |  |
| Drafting paper |  |  |  |  |  |  |  |  |  |  |  |  |
| Revising paper and submission to journal |  |  |  |  |  |  |  |  |  |  |  |  |
| Policy materials and seminar |  |  |  |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 4: GH4121-21** | | | | | | | | | | | |
| Outcome 4: Effective partnerships are built with farmers, local communities, and research and development partners in the private and public sectors to ensure delivery and uptake at scale of SI technologies, innovations and practices. | | | | | | | | | | | |
| a. Output 4.1 | | Alliances and effective partnerships developed between farmers, local communities, and research and development agents in the public and private sectors to enable the release, dissemination, and adoption of proven technologies and practices to scale. | | | | | | | | | |
| b. Activity 4.1.2 | | Identify (possibly map) and assess relevant stakeholders to establish dialogue for the exploration of mutual synergies for scaling delivery of validated technologies. | | | | | | | | | |
| c. Sub-activity GH4121-21 | | Utilize ICT and GIS tools to share information (agronomic, climatic and market services) and scale-out Africa RISING technologies in collaboration with strategic partnerships in the Region. | | | | | | | | | |
|  | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | |
| Name | | | | Institution | | | Role | | | | |
| Fred Kizito | | | | IITA | | | PI: Land and water management | | | | |
| Powell Mponela | | | | Alliance Bioversity CIAT | | | Partner on linkages of ICT to Agronomy and publications | | | | |
| Benedict Boyubie | | | | IITA | | | FtF indicators and ensure data are uploaded on Dataverse | | | | |
| Patrick Kiao | | | | ESOKO | | | ICT Independent tool development | | | | |
|  | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | |
| Beyond soil and water conservation, field observations in recent years have increasingly shown that farmers’ planning of timing of planting and agronomic management practices (e.g. timing of sowing, thinning, fertilizer application, harvesting, and storage) is helpful but needs further refinement and guidance. Proper planning offers numerous dividends such as early crop vigor, drought avoidance, tolerance to pests and diseases. The cropping calendar data from last year revealed interesting dynamics that will be shared with Africa RISING farmers as a resilience-enhancing approach. For example, based on the participatory survey data compared with specific planting dates ascertained from satellite data reveals differences between scientific estimations and farmers’ local knowledge. These will be synthesized into informative charts that assist farmers with more precise decision-making. This will be conducted in an integrated way by reaching out and communicating with our target audiences through an ICT platform that combines agronomy, markets, climate services, and postharvest information for the benefit of farmer empowerment. | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | |
| 2.1 Harness the power of ICT to share cropping-calendar messages and other agronomic, weather, and market information for farmers’ information empowerment | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 3. Research Questions | | | | | | | | | | | |
| 3.3 How can we use the power of ICT to co-develop and share with end-users a crop planning calendar for empowering farmer decision-making? | | | | | | | | | | | |
| 3.4 What would be the best strategy to map, engage and collaborate with strategic partnerships in the Region as a means to scale out promising SWC measures? | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | |
| Building on accomplishments from the previous season, the team has compiled and analyzed seasonal calendar information for use by farmers and development partners. The team intends to conduct training for efficient use of the seasonal calendar and provide refresher training for soil and water conservation measures for the communities in Bonia and Nyangua. The team has partially developed educational brochures and training manuals for educating and training farmers, development partners, and extension officers on cropping calendars for improved crop productivity thus developing both human and institutional capacity. The process will be concluded in this research cycle.  Building on activities conducted in sub-activities GH1211-19/20 and GH1212-19/20 and GH3211-19/20 in collaboration with ESOKO and WorldCover, we shall use ICT and GIS tools to share and disseminate information on proven agronomic practices as well as on the seasonal calendars (and planting dates information). This activity is an integrating activity across the interventions being promoted within Africa RISING. It will equally entail working closely with other work packages for packaging the right messages, and timing of message delivery to the end-users. It will also involve awareness-raising on the role and benefits of the platform including both farmers and extension officers. Some of the messages will be tailored around crop agronomy, climate services, market information, and post-harvest management practices. | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | Responsibility/Institute | | |
| Is the collected data part of a multi-year experiment/trial? Yes | | | | | | | | |  | | |
| 5.1 Co-share with end-users’ crop planning decision matrix:   * Historical planting dates for major staples * Date calendars for agronomic practices (e.g., timing of sowing, thinning, fertilizer application, harvesting and storage) | | | | | | | | | Powell Mponela- ABC  F. Kizito/IITA and W. Agyare/KNUST | | |
| 5.2 Develop both human and institutional capacity of target farmers towards improved soil and water conservation measures:  We shall assess the knowledge, attitude, skills and aspirations (KASA) of farmers before and after the training and capacity building exercises. The activity will take care of the training and capacity building needs of all the other sub-activities by the team. | | | | | | | | | Powell Mponela- ABC  F. Kizito/IITA and W. Agyare/KNUST | | |
|  | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | |
| Deliverables | | | | | Means of verification | | | | | Delivery date | |
| Standalone MWANGA Platform for private sector uptake | | | | | Semi-annual Project Report | | | | | Jun. 2022 | |
| Synthesis: Resilience in cereal-legume farming systems in the context of land and water management strategies | | | | | Semi-annual project report | | | | | Jun. 2022 | |
| Journal article on land and water management strategies in Cereal-Legume based farming systems | | | | | Published on CGspace | | | | | Jul. 2022 | |
| Database on land and water management strategies on Cereal legume-based farming systems | | | | | Database uploaded on Dataverse | | | | | Jul. 2022 | |
|  | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | |
| Domain | Indicator | | Metrics/Scale | | | Methods/  Approaches | | Before intervention | | | After intervention |
| 7.1 Economic | - Profitability  - Input Use Intensity | | - Net income ($/crop/ha/season) at the plot level  - Input per ha at the plot level  - In relation to the market information services received from the ICT platform | | | Computed from productivity data | |  | | |  |
|  | | | | | | | | | | | |
| 8. How will scaling be achieved? | | | | | | | | | | | |
| Strategic partnerships with both public and private sector entities. For the public sector: we shall liaise with MoFA, for the private sector specifically with WorldCover, and local universities. The use of ICT approaches in collaboration with ESOKO and WorldCover as well as participatory video methods and maps will be used as information sharing methods in the target sites with partners and will complement the scaling-up and out through farmer-to-farmer exchanges on soil and land management interventions that increase on-farm productivity. We link up with on-going initiatives and partnerships such as the Northern Agricultural Sector Working Group (NASWG) and Northern Rural Growth Development Program (NRGDP) as scaling pathways for our research. This will include sharing with them brochures developed for farmer training as well as co-sharing in-field experiences at working group discussions including MoFA as well. | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 9. How are the activities in this protocol linked to those of others? | | | | | | | | | | | |
| The activities on cropping calendars and ICT are all-encompassing in the sense that there is information shared on agronomy, climate services and market linkages for the different AR technologies. The training and capacity building will be conducted in liaison with the agronomic work. The proposed work will also link with sub-activity GH3211-19 on assessing buffer and adaptive capacity to harness resilience of different farm types. | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 10. Custom indicators | | | | | | | | | | | |
| * Synthesis: Resilience in cereal-legume farming systems in the context of land and water management strategies * Journal article on land and water management strategies in Cereal-Legume based farming systems * Database on land and water management strategies on Cereal legume-based farming systems | | | | | | | | | | | |
|  | | | | | | | | | | | |
| 11. Impact-based summary matrix | | | | | | | | | | | |
| 11.1 What is the development challenge you are addressing?  Food insecurity and poverty (household level) and NRM beyond the plot level: Through this research, the sub-activity will seek information about the vulnerabilities and resilience capacities of the target communities and how this contributes towards reducing food insecurity and poverty and enhance the natural resource base. | | | | | | | | | | | |
| 11.2 Who is your target audience, e.g., extension agents, farmers, or policymakers?  Smallholder farmers, agricultural extension agents, donors (USAID) and policymakers. | | | | | | | | | | | |

12. Budget

|  |  |  |  |
| --- | --- | --- | --- |
| Budget line | ESOKO\* | IITA | Alliance Bioversity-CIAT |
| Personnel | 0 | 0 |  |
| Services\*\*\* | 2,940 | 2,900 | 22,100 |
| Supplies | 0 |  |  |
| Capital | 9,653 | 1,685 |  |
| Travel | 0 | 3,000 |  |
| Overhead | 0 | 0 | 3,315 |
| Total | 12,593 | 7,585 | 25,415 |
| Grand total | 45,593 | | |

\*Please see attached concept note with ESOKO on a collaborative initiative for making the MWANGA platform an independent tool that can be handed over to private sector.

\*\*\*Includes costs of engaging ICT consultancy on key messaging

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| --- | --- | --- | --- | --- | --- | --- | --- |
| 13. Gantt chart | | | | | | | |
| Year/ month | 2022 | | | | | | |
| Jan | Feb | Mar | Apr | May | Jun | Jul |
| Training |  |  |  |  |  |  |  |
| Consultancy engagements |  |  |  |  |  |  |  |
| Designing key messages |  |  |  |  |  |  |  |
| M&E for verification |  |  |  |  |  |  |  |
| Mwanga Dashboard Development |  |  |  |  |  |  |  |
| Mwanga Dashboard validation |  |  |  |  |  |  |  |
| Platform messages dissemination |  |  |  |  |  |  |  |
| Data collection (M&E on Mwanga usefulness) |  |  |  |  |  |  |  |
| Semi-annual report |  |  |  |  |  |  |  |
| End of project community field days |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 4: GH4122-21** | | | | | | | | | |
| Outcome 4: Effective partnerships are built with farmers, local communities, and research and development partners in the private and public sectors to ensure delivery and uptake at scale of SI, technologies, innovations and practices | | | | | | | | | |
| a. Output 4.1 | | Alliances and effective partnerships developed between farmers, local communities, and research and development agents in the public and private sectors to enable the release, dissemination, and adoption of proven technologies and practices to scale | | | | | | | |
| b. Activity 4.1.2 | | Map and assess relevant stakeholders to establish dialogue for the exploration of mutual synergies for scaling delivery of validated technologies | | | | | | | |
| c. Sub-activity GH4122-21 | | Promotion and dissemination of Africa RISING validated SI interventions for sustained productivity and reduced risk in Ghana using the climate-smart village approach | | | | | | | |
| d. Research team | | | | | | | | | |
| Name | | Institution | | Role | | | | | |
| Prince M. Etwire | | SARI | | Principal Investigator: Responsible for the overall implementation and coordination of sub-activity, data collection, data analysis, and final report  Contribution to participatory integrated climate services for agriculture (PICSA) and monitoring and evaluation. | | | | | |
| Samuel Saaka Buah | | SARI | | Provide Technical Backstopping to the Team | | | | | |
| Boasiako Ohene Antwi | | KNUST | | Contribution towards the data collection on climate smart agriculture practices | | | | | |
| Abdul Rahman Nurudeen | | IITA | | Contribution towards data collection on agronomy and plant nutrition | | | | | |
| Fred Kizito | | IITA | | Provide technical backstopping | | | | | |
| Mathieu Ouedraogo | | CCAFS/ICRISAT | | Contribution to the design of monitoring tool for the modification and adoption of the climate smart agriculture practices | | | | | |
| The District Directors | | Department of Agriculture (DoA) | | Assist in the dissemination of Africa RISING SI technologies and information through extension services | | | | | |
| Benedict Boyubie | | IITA | | Compilation of FtF indicators and uploading data on Dataverse | | | | | |
|  | | | | | | | | | |
| e. Student(s) | | | | | | | | | |
| Name | | Institute | | Degree | | Start | | | End |
| Nil | |  | |  | |  | | |  |
|  | | | | | | | | | |
| f. Location(s) | | Northern (Tingoli, Cheyohi no. 2, Doku, Tibali), Upper East (Samboligo, Nyangua, Gia, Bonia), Upper West (Zanko, Guo, Goli, Goriyiri) regions | | | | | | | |
|  | |  | | | | | | | |
| g. Start | | December 2019 | | | | | | | |
|  | |  | | | | | | | |
| h. End | | May 2022 | | | | | | | |
|  | | | | | | | | | |
| 1. Justification | |  | |  | |  | | |  |
| **Statement of the problem** The livelihoods of the majority of rural people in Ghana depend on rainfed production systems that are vulnerable to climate variability and change. In the context of the observed increasing climate variability and uncertainty, access to and use of reliable climate information to inform decisions in the agricultural sector are, therefore, becoming instrumental to strengthening farmers’ resilience to climate shocks. Climate services involve the timely production, translation, and delivery of useful climate data, agronomic information, and knowledge for proper and timely farming decision-making by farmers. By addressing these challenges, synergies between climate change adaptation goals, and competitive strategies in food value chains, the resilience of the food systems may be achieved. To help farmers cope with the negative impact of climate change, CSIR-SARI with support from IITA through the Africa RISING West Africa Project and in collaboration with the Ghana Meteorological Services will work with farmers in the project communities to analyze historical climate data and on that basis predict the season’s weather and identify agricultural options to adapt to the expected weather. | | | | | | | | | |
|  | | | | | | | | | |
| 2. Objectives: The main objective is to enhance the capacity of agricultural stakeholders for efficient use of climate information services and big data to increase farm resilience to climatic change for sustained productivity and reduced risk in the intervention communities. | | | | | | | | | |
| 2.1 Assess farming and livelihoods in the intervention communities. | | | | | | | | | |
| 2.2 Promote the use of climate information as a basis for farm management decisions | | | | | | | | | |
| 2.3 Promote the adoption of CSA technologies and practices (of which Africa RISING SI technologies form part) based on local needs for improved adaptive capacity to climate change and variability | | | | | | | | | |
| 2.4 Capacitate farmers and extension agents in climate change and climate-smart agriculture through community trainings with pre-developed content | | | | | | | | | |
|  | | | | | | | | | |
| 3. Research questions | | | | | | | | | |
| 3.1 How will climate, soil, production, and socio-economic factors that informed choice and use of Africa RISING SI technologies be used to further promote the technologies? | | | | | | | | | |
| 3.2 How does provision and use of climate information services relate to farm productivity and livelihoods of smallholder farm communities based on a choice from the Africa RISING SI technologies? | | | | | | | | | |
| 3.3 What combinations of SI technologies are attractive to farmers, reduce vulnerabilities and increase the likelihood of adoption? | | | | | | | | | |
|  | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | |
| 4.1 Conducting surveys at the community level to assess climate risk and gender and social inclusion analysis; 4.2 Focus group discussions with men and women farmers will be conducted to generate data on social SI indicators and farmers’ views about climate change and variability in general. 4.3 Participatory identification and prioritization of Africa RISING SI technologies based on biophysical, socio-economic, gender, policy, and institutional context; also considering possible synergies and trade-offs amongst individual activities. The PICSA approach would be complemented with the Sustainable Intensification Assessment Framework (SIAF). SIAF provides a set of indicators organized into five domains considered as critical for sustainability, namely productivity, economic, environment, human condition, and social domains. The primary goal for implementing the SIAF would be to strengthen our ability to holistically assess the performance of the Africa RISING SI technologies in terms of the direct and indirect consequences within and across domains. 4.4 Provision of climate information services to farmers using climate forecast communication and the PICSA approach 4.5 Evaluation of portfolios of Africa RISING SI technologies (e.g. providing value-added weather services to farmers, building capacity in climate change adaptation, and facilitating community partnerships for knowledge sharing) 4.6 Evaluation of farmers knowledge and perception of climate-smart interventions (e.g. cowpea living mulch’ time of fertilizer application, drought-tolerant maize varieties), and determination of climate, farm, and farmer characteristics that influence the choice of SI technologies 4.7 Capacity building for the scaling up of climate-smart interventions through policies and institutions, and scaling out to large areas through the farm-to-farm approach | | | | | | | | | |
|  | | | | | | | |  | |
| 5. Data to be collected and uploaded | | | | | | | | Responsibility/Institution | |
| Is the collected data part of a multi-year experiment/trial? Yes | | | | | | | |  | |
| 5.1 Quantitative and qualitative socioeconomic data (Information on attitudes and opinions on climate change and adaptation). | | | | | | | | Etwire/SARI | |
| 5.2 Historic weather information for the project sites and annual weather data throughout the study. Sites will include the Africa RISING communities in the NR, UER and UWR. | | | | | | | | Etwire/SARI | |
|  | | | | | | | | | |
| 6. Milestones | | | | | | | | | |
| Deliverables | | | | | Means of verification | | | Delivery date | |
| 6.1 Insights in potential SI adoption impacts of selected validated technologies/practices | | | | | Technical report to IITA | | | Dec. 2021 | |
| 6.2 Training workshop of farmers and extension agents in climate change and Africa RISING SI technologies | | | | | Training report included in technical report to IITA | | | Feb. 2022 | |
| 6.3 Climate information delivered to farmers through the climate forecast communication workshop and the PICSA approach | | | | | Activity report | | | Apr. 2022 | |
| 6.4 Assessment of Climate-Smart interventions | | | | | Activity report included in technical reports to IITA | | | May. 2022 | |
| 6.5 Final contributions for the WA handbook | | | | | Submitted to Africa RISING manager | | | 31 Mar. 2022 | |
|  | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | |
| Domain | Indicator | | Metrics/Scale | | Methods/ Approaches | | Before intervention | After intervention | |
| 7.1 Economic | Profitability, Labor  Requirement | | Net income at plot/ field level  Labor requirement  (hours/ha) at plot/  field level | | Survey and farmer  Evaluation | | Marginal rate of return  Full manure: 4.77  ½ rate fertilizer: 4.67  ½ manure + ½fertilizer: 10.88  Full rate fertilizer: -4.17 | Farmer evaluation  After intervention | |
| 7.2 Social | Gender equity Technology assessment by gender Social cohesion | | Rating of technologies by gender at household level Access to information/ education Collective action groups at the community level | | Farmer evaluation | |  | Farmer assessment after intervention | |
| 7.3 Human | Capacity to experiment Social cohesion | | Number of new practices being tested at household level -% of farmers experimenting at community level | | Lookup tables and survey | | Four | Survey after intervention | |

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| 8. How will scaling be achieved? |
| Scaling will be achieved through strategic partnerships with organizations such as the Department of Agriculture (DoA), Ghana Metrological Service, and Non-Governmental Organizations such as the Mennonite Economic Development Associates (MEDA) and by organizing stakeholder meetings with farmers, extension officers, and traditional leaders on the results of the PICSA which will lead to the development of media materials (posters, fact sheets, leaflets) for extension staff, farmers, etc. Exchange visits for farmers and researchers; training of trainers and hands-on training for farmers, community outrage programs (Local FM stations), and traditional durbars will be used to communicate to the wider public. The number of farmers reached by these outreach methods would be estimated. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| The PICSA assesses technologies that farmers utilize to adapt to the effects of climate change and variability. Therefore, the approach will lead to a better understanding of the adoption potential of these proven technologies and opportunities for scaling up. |
|  |
| 10. Custom indicators |
| * 500 farmers in project communities trained * 12 meetings organized in project communities and 2 workshops conducted * 1 project report produced * 3 technical leaflets and 1 policy briefs produced including contribution to the “Medicine Labels”) * 1 journal article submitted/published * Contribute to AR-WA handbook * Activity reports are captured in 2021 – 2022 CSIR-SARI bi-annual reports |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing? Food insecurity, natural resource management, and climate change adaptation. This sub-activity will address the following major development challenges. (I) food insecurity, (ii) the sub-activity will also reduce the negative effects of climate change and variability on crop productivity, (iii) it will also increase farmers' adaptive capacity to climate change and contributes to increasing crop productivity in the area, and (iv) increased productivity can also contribute to a profitable crop enterprise thereby improving household income. |
| 11.2 Who is your target audience, e.g. extension agents, farmers, or policymakers?  Farmers (smallholder crop and livestock farmers), extension agents, and policymakers. |

|  |  |
| --- | --- |
| 12. Budget (US$) | |
| Budget Line | SARI |
| Personnel | 4,950 |
| Services | 3,900 |
| Capital | 2,780 |
| Travel | 3,800 |
| Overhead | 2,315 |
| Total | 17,745 |

13. Gantt Chart

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Year/Month | 2020 | | | 2021 | | | | |
| Jan | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May |
| Farmer engagement |  |  |  |  |  |  |  |  |
| Training |  |  |  |  |  |  |  |  |
| Assessment of Africa RISING SI technologies |  |  |  |  |  |  |  |  |
| M&E for verification |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 4: GH4311-21** | | | | | | | | | | | | | |
| Outcome 4: Effective partnerships are built with farmers, local communities, and research and development partners in the private and public sectors to ensure delivery and uptake at scale of SI technologies, innovations and practices are built | | | | | | | | | | | | | |
| a. Output 4.3 | | | | A framework for monitoring and evaluating technology adoption, and technology-associated risk accessible to the project team and scaling partners | | | | | | | | | |
| b. Activity 4.3.1 | | | | Monitor and modify the progress of technology adoption process towards scaling | | | | | | | | | |
| c. Sub-activity GH4311-21 | | | | Matching agricultural technologies to farms and their context | | | | | | | | | |
|  | | | |  | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | |
| Name | | Institution | | | | Role | | | | | | | |
| Jeroen Groot | | WUR | | | | Farming systems analysis (Activity Leader) | | | | | | | |
| Francis Muthoni | | IITA | | | | GIS | | | | | | | |
| Beliyou Haile | | IFPRI | | | | Economic analysis | | | | | | | |
| Lieven Claessens | | IITA | | | | Farming systems analysis | | | | | | | |
| Carlo Azzarri | | IFPRI | | | | Economic analysis | | | | | | | |
| Benedict Boyubie | | IITA | | | | FtF indicators and data uploading on Dataverse | | | | | | | |
|  | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | |
| Name | | | Institute | | | | Degree | Start | | | End | | |
| NIL | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| f. Location(s) | Districts in NR, UER, UWR | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| g. Start | 1 September 2019 | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| h. End | 30 June 2022 | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | |
| Increasingly, mobile phones and other ICT services are used to provide information and advice to farmers to facilitate learning, but support to targeting and scaling agricultural technologies through ICT tools is scarce. ICT-based targeting and scaling approaches should not be considered a silver bullet, although they can increase the reach and reduce the costs of technology dissemination compared to traditional village extension services.  Sophisticated models of technology integration in farming activities exist, but they are often very data-intensive and do not extend beyond the farm level. Muthoni *et al*. (2017[[72]](#footnote-73)) utilized spatially gridded biophysical and socio-economic layers to generate what they called “sustainable recommendation domains” (SRDs) that could be targeted for scaling specific technologies. The effectiveness of the suitability assessment can be further refined as long as the features of individual farms are considered and directly related to technology characteristics during the targeting phase. Innovations in coupling knowledge among site characteristics, household features, and technology attributes with the SRDs are needed to guide the spatial targeting of suitable technologies.  The FarmMATCH approach explicitly tries to fill this knowledge gap, facilitating the matching between agricultural technologies to farms and their context. It contains 1) a learning and matching algorithm that identifies the most suitable and promising technologies for different farm types, and 2) a data mining and signaling algorithm that identifies hotspots of the suitability of technologies and potential adopters. The matching algorithm combines contextual, farm, and technology characteristics to create a ranking of the suitability and adoption probability of available innovations. | | | | | | | | | | | | | |
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| 2. Objectives | | | | | | | | | | | | | |
| 2.1 Test and improve the ‘matching’ algorithm on a large dataset | | | | | | | | | | | | | |
| 2.2 Determine the ease of scarce data collection at farms | | | | | | | | | | | | | |
| 2.3 Obtain feedback from farmers on the technology priority lists | | | | | | | | | | | | | |
| 2.4 Develop a mechanism for feeding collected data to the database and improve algorithm learning | | | | | | | | | | | | | |
| 2.5 Develop the ‘signaling’ algorithm | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | |
| 3.1 What is the quality of the generated priority lists for large samples of farms in different agroecological and socioeconomic conditions? | | | | | | | | | | | | | |
| 3.2 Can the necessary set of scarce data be collected swiftly and reliably from farmers upon farm visit? | | | | | | | | | | | | | |
| 3.3 What is the farmers’ perception of the generated priority list of technologies suggested for implementation? | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | |
| 4.1 Data collection: GIS and GARBES databases for intervention areas in Northern Ghana will be used to select 1 km2 grid cells with surveyed households. A minimal set of supplementary data on farm and household features and on-farm technologies and practices may be collected.  4.2 We select 15-30 grid cells of 1 km2 from the three Northern regions of Ghana (NR, UER, UWR), so 5-10 cells per region. These cells differ in biophysical conditions (soil, rainfall, etc.) and socio-economic circumstances (e.g., distance to market). Moreover, within these cells we have at least 10 households sampled within the GARBES database collected by IFPRI; if this is not the case then additional data collection is required. In total ca. 300 farms will be included. There should also be diversity among the sampled households in the grid cell. For each household, we analyze, in particular, the main and easy-to-collect farm and household features (size, objectives, livestock, crop number, % off-farm income, etc.) and relate these to the farm practices and project-proposed technologies and techniques. The matching algorithm combines the GIS-derived data on biophysical conditions and socio-economic context circumstances with the farm features, to estimate the probability of use of the various technologies and techniques. The data set will be divided between a training set (n=200-240) and a testing set (n=60-100). | | | | | | | | | | | | | |
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| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | Responsibility/Institute | | | | |
| Is the collected data part of a multi-year experiment/trial? No | | | | | | | | |  | | | | |
| 5.1 Compiled dataset | | | | | | | | | Jeroen Groot, WUR | | | | |
| 5.2 Programmed algorithms | | | | | | | | | Jeroen Groot, WUR | | | | |
|  | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | Delivery date | | | |
| 6.1 Journal article 1 (concept presentation) | | | | | | | PDF of submitted paper | | | Mar. 2022 | | | |
| 6.2 Journal article 2 (country comparison) | | | | | | | PDF of report | | | May 2022 | | | |
| 6.3 Datasets and algorithms | | | | | | | Items uploaded in Dataverse | | | Jun. 2022 | | | |
|  | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | |
| Domain | | Indicator | | | Metrics/Scale | | | Methods/ Approaches | Before intervention | | | After intervention | |
| 7.1 Human condition | | Capacity to experiment | | | Willingness to implement a new farm configuration after disturbance | | |  |  | | |  | |
| 7.2 Social | | Equity | | | Rating of farm configurations per group and agency (leadership roles) | | |  |  | | |  | |
|  | | | | | | | | | | | | | |
| 8. How will scaling be achieved? | | | | | | | | | | | | | |
| The modeling results will be discussed in farmer meetings. Findings will be shared and published. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 9. How are the activities in this protocol linked to those of others? | | | | | | | | | | | | | |
| The activity is linked to GH1211-21 | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 10. Custom indicators | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 11. Impact-based summary matrix | | | | | | | | | | | | | |
| 11.1 What is the development challenge you are addressing?  Increasingly, mobile phones and other ICT services are used to provide information and advice to farmers to facilitate learning, but support to targeting and scaling agricultural technologies through ICT tools is scarce. The FarmMATCH approach explicitly tries to fill this knowledge gap, facilitating the matching between agricultural technologies to farms and their context. | | | | | | | | | | | | | |
| 11.2 Who is your target audience, e.g., extension agents, farmers, or policymakers?  Smallholder farmers, agricultural extension agents, and policymakers | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 12. Budget (US$) | | | | | | | | | | | | | |
| Budget line item | | | | | | | | WUR | IITA | | | | IFPRI |
| Personnel | | | | | | | | 0 | 0 | | | | 0 |
| Services | | | | | | | | 0 | 0 | | | | 0 |
| Supplies | | | | | | | | 0 | 0 | | | | 0 |
| Capital | | | | | | | | 0 | 0 | | | | 0 |
| Travel | | | | | | | | 0 | 0 | | | | 0 |
| Overhead | | | | | | | | 0 | 0 | | | | 0 |
| Total | | | | | | | | 0 | 0 | | | | 0 |
| Grand total | | | | | | | | 0\* | | | | | |

\*There is no budget assigned for 20212022 since the sub-activity was carried over from 2020/2021 and is in the process of finalizing the deliverables.

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| 13. Gantt chart | | | | | | | | | |
| Year/ month | 2021 | | | 2022 | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
| Starting |  |  |  |  |  |  |  |  |  |
| Make GIS maps with grid cells |  |  |  |  |  |  |  |  |  |
| Compile ARBES data in relational DB |  |  |  |  |  |  |  |  |  |
| Test machine learning algorithms on data |  |  |  |  |  |  |  |  |  |
| Drafting paper for scientific journal |  |  |  |  |  |  |  |  |  |
| Revising paper and submission to journal |  |  |  |  |  |  |  |  |  |
| Ending |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 1: GH4312-21** | | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable and sustainably intensified crop-livestock systems linked to markets. | | | | | | | | | | | | | | |
| a. Output 4.3 | | | An updated framework for monitoring technology adoption to be used by the project team and scaling partners available and accessible | | | | | | | | | | | |
| b. Activity 4.3.1 | | | Monitor and report technologies and their associated beneficiaries or farmers exposed to the innovations using the tools developed by IFPRI | | | | | | | | | | | |
| c. Sub-activity GH4312-21 | | | Investigate the distribution of benefits from diverse agricultural interventions | | | | | | | | | | | |
|  | | |  | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | |
| Name | | | | | Institution | | | Role | | | | | | |
| Eva Thuijsman | | | | | WUR | | | Model development, analysis, reporting | | | | | | |
| Bekele Kotu | | | | | IITA | | | Economist: econometric methods | | | | | | |
| Abdul Rahman Nurudeen | | | | | IITA | | | Agronomist: model assumptions on productivity | | | | | | |
| Fred Kizito | | | | | IITA | | | Overall guidance on relevance and context | | | | | | |
|  | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | Degree | | Start | | | End |
| NIL | | | |  | | | | |  | |  | | |  |
|  | | | | | | | | | | | | | | |
| f. Location(s) | | Ghana: Northern, Upper West, Upper East Regions | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| g. Start | | March 2019 | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| h. End | | July 2022 | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | |
| Purpose of the study  When differentiated impacts are observed among poor and better-off rural households, explanations are primarily sought in existing inequalities, for instance, investment capacity and farm sizes (Thuijsman et al., submitted[[73]](#footnote-74)). Some people benefit more because they have better means to generate returns. However, technologies need not be only neutrally subjected to existing distributions—they can also drive differentiation when they induce changes, for instance in resource access and availability, and labor hiring and exchange practices. An intervening project can vary only the characteristics of a suggested technology, so it is important to understand how technology properties can influence impact distribution patterns. Hence, we will use a model to explore what impact patterns emerge when changing the characteristics of the technology only.  Rural households are usually examined as if they exist in isolation, with their own resource bases and enterprise patterns. They are compared with each other, but interactions and interdependencies at the farm system level are rarely considered. We will use a model to explore *indirect* effects of technology adoption, such as employment provision, labor displacement, and changes in total labor availability.  The model is not intended to perfectly mirror the complexity of a specific farming system, but rather to explore the patterns that emerge upon varying technology labor requirements in a system where labor is exchanged. Thus, it will deepen understanding of the interplay between technologies and interdependent rural households and inspire new theories and hypotheses.  If the developments with the COVID pandemic permit, we will directly follow up on these hypotheses and test our model assumptions with research in case study sites in northern Ghana.  A focus on labor interdependencies  New technology likely has different cash and labor requirements than its alternative practice. Households can negotiate access to labor, capital, and land, according to diverse mechanisms of decision-making. Access to capital and land can be acquired through credit systems, tenancy, lending, etc. and once capital is spent, it is spent. The model, therefore, focused on a more versatile resource: labor. Its investment is one of cash, time, and physical effort of one or more persons, who can work simultaneously or provide the same service several times at different farms. The cash-constrained can try to find ‘free’ sources of labor in their family or community, or they may offer to work in exchange for cash. Mechanisms of exchange can influence labor access, costs, timeliness, and can allow for indirect benefits from intensification via wage labor opportunities. For people deprived of financial capital, their labor resources are especially precious, as illustrated by the Kiswahili saying: “mtaji wa maskini ni nguvu zake mwenyewe,” which translates “the asset of the poor is his/her labor power” (as read in Mduma & Wobst, 2005[[74]](#footnote-75)).  New technologies are likely to change the labor requirements for production, and hence the labor hiring practices in rural areas. Labor-intensive technologies may contribute to peaks in labor demand, which often involve a movement of poor laborers to the farms of the better-off who offer wages (La Rovere et al., 2008; Natcher et al., 2018[[75]](#footnote-76)). Wage labor can be an important opportunity for those who need cash—but selling labor can come at the cost of productive tasks on the laborers’ own land. Simultaneously, poor laborers are at a disadvantage in making use of casual labor pools themselves (Singh and Jain, 1981[[76]](#footnote-77)). Labor-reducing technologies can provide an opportunity to move away from backbreaking production but can be problematic as well if they displace the labor of those whose livelihoods depend on hiring out their labor (e.g. Beuchelt and Badstue, 2013[[77]](#footnote-78)). A study in Malawi for instance showed that better-off farmers using herbicides no longer required the weeding services of the poor, leaving them to go hungry (Bouwman et al., 2020[[78]](#footnote-79)). Hence, labor-saving and labor-requiring technologies can each have unintended negative impacts but also positive impacts, via labor relations and interdependencies among farming households. Therefore, it is important to investigate labor dynamics upon a technological intervention. Models are a suitable tool for exploring such trade-offs, as technology properties and labor distribution mechanisms can easily be varied and tested. | | | | | | | | | | | | | | |
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| 2. Objectives | | | | | | | | | | | | | | |
| 2.1 Understand the drivers of (un)equal livelihood outcomes of agricultural interventions | | | | | | | | | | | | | | |
| 2.2 Assess the contribution of agricultural interventions to resilience | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | |
| 3.1 How do agricultural technologies influence (in)equality and resilience? | | | | | | | | | | | | | | |
| 3.2 What are the contextual drivers (e.g., resource access, interdependencies, risks) of (un)equal technology outcomes? | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | |
| Agent-based models (ABMs)  ABMs are used to assess what system-level patterns emerge from the decisions and actions of autonomous agents who interact with each other and with their environment. Each agent has objectives, seeks to fulfill these, may interact to do so, may react to what it encounters, and may even change its initial objective. This makes ABMs particularly suitable for simulating social systems. ABMs enable population-level analysis that is more than the sum of individual-level functions.  The incorporation of interactions is one of the main ways in which ABMs differ from conventional classical economic models that assume rational, isolated actors with unlimited cognitive resources (Barnaud et al., 2008[[79]](#footnote-80)). ABMs facilitate the simulation of interactions like resource exchanges and cooperation, as well as bounded rational and heuristic behavior (Castillo and Saysel, 2005[[80]](#footnote-81)).  Model functionality  The objective of the ABM is to test the sensitivity of impact distribution patterns to the labor costs of a technology (relative to a baseline practice), when simple mechanisms of resource exchange apply (family, communal, and hired labor), at different levels of population-level labor availability. Examples of impact ‘patterns’ are synergistic (everybody benefits) or zero-sum (some people benefit at the expense of others) distributions, and the level of inequality in technology impacts. Model output indicators include Gini and Robin Hood indices, the percentage of the population with increasing or decreasing wealth, and the total wealth gained or lost per wealth category.  The ABM represents a farming system, with agents (rural households) connected within it. The variable parameter in the model will be the technology labor costs (hours ha-1), at fixed returns ($ ha-1). Agents will each determine whether the technology is attractive, and then seek (or not) to acquire or offer labor in their network based on expected technology returns, opportunity costs, and profit/leisure preferences. Labor sources include family laborers (first choice, costing time, no cash), communal labor (reciprocal, costing twice the time, no/some cash), and wage laborers (costing cash). Wealth balances are then updated based on technology returns and wages paid and received. The ABM will include the temporal dimension of labor requirements and availability, i.e., incorporate time-saving through working in groups and time windows within which to execute practices. Risks will be incorporated through the chance of obtaining yields that are lower than expected, or sickness of the workforce.  The model will be dynamic, as there need to be several feedback loops throughout a model run. When the model is run, agents first solve a multi-objective problem (maximize profit and leisure time) as they estimate whether it is lucrative to implement a new technology and which labor sources to use to do so. Whether labor services can be acquired or offered in a network depends on the decisions of other agents. Hence, agents may need to update their objectives. Another system feedback occurs when the cash balances of agents are updated (wages received/paid, technology returns), and subsequently invested (or not) in following cropping seasons. Farming involves a sequence of practices and hence repeated sourcing of labor.  The multi-objective problem (maximize profit and leisure time) is subjected to limits, such as maximum hours of work in a day per person, labor availability in the household and/or the community, and estimation error.  **Africa RISING data that form the basis**  The ABM will be grounded in existing cases in Ghana (Northern, Upper East, Upper West Region), using data from Africa RISING. Input data include:   * **Household characteristics** in an Africa RISING sites in northern Ghana   + Household size, farm size, wealth level (income / running capital), farm vs non-farm income and expenditure ratios, labor hiring in/out practices * **Agronomic performance** of Africa RISING technologies and a baseline practice for comparison   + Yield increase, time window for activity and yield penalties, economic returns * **Labor requirements** of these technologies and a baseline practice   + Hours per activity, ideally disaggregated by gender   + There was also mention of data on how technology labor relates to labor usage on the rest of the farm (and allocation to off-farm livelihood activities), which is very relevant to know * Literature and experts will be consulted for information on:   + **Strategies and preferences** of farmers towards pursuing profit and leisure time, e.g., maximizing vs satisficing, preference ratios (see e.g., Williams et al. 2020 using leisure/profit objective ratios).   + The nature of **social networks, conditions for labor exchange, wages**.   The model is a quantitative simplification of reality, and the assumptions will be transparently elaborated on and their implications discussed. The model will be accompanied by a literature study with due attention to the nuance and variation we find in real life.  **Linking theory and practice**  If the developments with COVID permit, the theoretical model exercise will be followed-up upon with research in the case study sites in northern Ghana. Going to these sites gives an opportunity to test and improve model assumptions and compare model results with the experiences of Africa RISING technology users and non-users.  I will first interview a random sample of Africa RISING beneficiaries and will use the snowball method for sampling further study participants (Goodman, 1961). In this method, respondents are asked to identify one or a few other potential participants, in this case, based on for instance collaborations, competition or (displaced) service provision. These participants can include direct project beneficiaries and others. The unit of analysis is the individual rather than the household, to allow for capturing intra-household inequities.  Topics during semi-structured interviews include the goal for which participants implement an Africa RISING technology, the availability of alternatives to reach the same target, and how these technologies may affect access to resources (type, quantity, quality, timing) for different people. Another key topic during interviews will be resilience, particularly the role that Africa RISING technologies might have had in resilience capacities in relation to locally relevant perceived risks, and the recent COVID shock.  In interactive exercises, I will draw with the participant calendars of supply and demand of resources (with quantification), and networks of collaboration, using colored tokens as symbols to facilitate the discussion. The focus will be on labor, but I will specifically enquire about other resources as well to identify trade-offs and synergies. Relations will be discussed in detail, to derive whether the poorer and better-off fulfill particular roles regarding the implementation of an intervention and in agricultural development project participation. I will derive from this the characteristics of the marginalized in the study village so that I can identify them and include them in the research. I will also interview owners, middlemen, managers, and users of shared resources and infrastructure to assess conditions for access and use. For the same purpose, I will observe during some group meetings (e.g., for organizing labor or cash saving). | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded | | | | | | | | | | | | | Responsibility | |
| 5.1 Anonymized interview data about direct and indirect technology impacts, resource use and availability | | | | | | | | | | | | | Thuijsman (WUR) | |
|  | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | End date | | | |
| 6.1 Report on drivers of differentiated technology impacts – focused on labor | | | | | | | Report on model analysis | | | | Dec. 2021 | | | |
| 6.2 Research in study sites to test model assumptions | | | | | | | Technical report | | | | Mid 2022 (Covid-dependent) | | | |
| 6.3 Manuscript on technology use and labor dynamics | | | | | | | Draft manuscript | | | | Jun. 2022 | | | |
|  | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | |
| Domain | Indicators | | | | | Metric & Scale | | | | Approach used in data collection | | Before intervention | | After intervention |
| 7.1 Productivity | Variability of maize/legume yields/production | | | | | Rating of production risk,  % harvest lost, farmer level | | | | Interviews | |  | |  |
| 7.2 Environmental | Resource availability | | | | | Natural resource distributions, irrigated land, map, community level | | | | Interviews, transect walks | |  | |  |
| 7.3 Economic | Variability of profitability;  Income Diversification;  Market orientation | | | | | Welfare categorization, assessment of livelihood strategies, calendars of resource supply and demand, farmer and community level | | | | Interviews, interactive exercises | |  | |  |
| 7.4 Social | Equity  Labor access and roles  Drudgery | | | | | Access to resources, capacity (access to information), achievements (resilience), variability and distributions, drudgery scores: farmer and community level | | | | Interviews, network analysis | |  | |  |
| 7.5 Human | Food security | | | | | Food availability, accessibility, at farmer and community level | | | | Interviews | |  | |  |
|  | | | | | | | | | | | | | | |

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| 8. How will scaling be achieved? | |
| The model helps to understand the unintended consequences of the implementation of interventions in a differentiated population. It can guide the scaling approaches of Africa RISING technologies (by Africa RISING and those building on their legacy in the future), towards improved equity and resilience. | |
|  | |
| 9. How are the activities in this protocol linked to those of others? | |
| The ABM development and simulations will therefore involve close collaboration with Africa RISING scientists who have been involved in the interventions, monitoring, and evaluation, agronomic research, economic assessments, and studies on (gendered) labor requirements. The ABM uses existing Africa RISING data. The proposed plan, therefore, fits with the current phase of Africa RISING wherein existing data are analyzed and knowledge synthesized. Besides, the planned field research fits with Africa RISING’s phase wherein its contribution can be assessed and evaluated. | |
|  | |
| 10. Custom indicators | |
| Report on the model study on labor interdependencies concerning agricultural technology | Report on field research about the drivers of (un)equal livelihood outcomes of agricultural interventions |
|  | |
| 11. Impact-based summary matrix | |
| 11.1 What is the development challenge you are addressing?  Unequal distributions of benefits of agricultural interventions, the risk of the poor losing out in progress toward resilience | |
| 11.2 Who is your target audience, e.g., extension agents, farmers, or policymakers?  Intended beneficiaries and extension agents. | |

|  |  |
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| 12. Budget (US$) | WUR |
| Personnel |  |
| Services | 4,000 |
| Supplies | 3,000 |
| Capital |  |
| Travel | 3,000 |
| Overhead |  |
| Total | 10,000 |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 13. Gantt chart | | | | | | | | | |
| Year/ month | 2021 | | | 2022 | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
| Model development |  |  |  |  |  |  |  |  |  |
| Model analysis and reporting |  |  |  |  |  |  |  |  |  |
| Preparation for field study |  |  |  |  |  |  |  |  |  |
| Data collection |  |  |  |  |  |  |  |  |  |
| Data processing and analysis |  |  |  |  |  |  |  |  |  |
| Preparing manuscript |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 4: GH4313-21** | | | | | | | | | | | | | |
| Outcome 4: Effective partnerships are built with farmers, local communities, and research and development partners in the private and public sectors to ensure delivery and uptake at scale of SI, technologies, innovations and practices | | | | | | | | | | | | | |
| a. Output 4.3 | | | An updated framework for monitoring technology adoption to be used by the project team and scaling partners available and accessible | | | | | | | | | | |
| b. Activity 4.3.1 | | | Monitor and report technologies and their associated beneficiaries or farmers exposed to the innovations using the tools developed by IFPRI | | | | | | | | | | |
| c. Sub-activity GH4313-21 | | | Addressing constraints limiting adoption of SI technologies as a result of competing interests for natural and other household resources | | | | | | | | | | |
|  | | |  | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | |
| Name | | | | | Institution | | | | Role | | | | |
| Alhassan Lansah Abdulai | | | | | CSIR-SARI | | | | Lead Investigator: Coordination of sub-activity, data collection, data analysis, development of management strategies for competing interests, and final report writing | | | | |
| Iddrisu Yahaya | | | | | CSIR-SARI | | | | Coordination of the development of survey instrument, training of enumerators, data collection and analysis, and report on competing interests | | | | |
| Fred Kizito | | | | | IITA | | | | Contributing to the development of survey instrument, data analysis, and development of management strategies for competing interests | | | | |
| Benedict Ebito Boyubie | | | | | IITA | | | | Developing data collection tools, training of the research team on Feed the Future indicators and supporting data collection to track output level and Feed the future indicators,  Ensuring data upload on Dataverse | | | | |
|  | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | | Degree | | Start | End |
| NIL | | | |  | | | | | |  | |  |  |
|  | | | | | | | | | | | | | |
| f. Location(s) | | Northern Region (Tingoli, Cheyoli No2, and Duko ); Upper West Region (Guo, Goli, and Goriyiri); Upper East Region (Nyanguo, Gia, and Bonia) | | | | | | | | | | | |
|  | |  | | | | | | | | | | | |
| g. Start | | July 2019 | | | | | | | | | | | |
|  | |  | | | | | | | | | | | |
| h. End | | June 2022 | | | | | | | | | | | |
|  | |  | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | |
| Northern Ghana has a very fragile climate which requires the use of sustainable intensification interventions to ensure that smallholder farmers can benefit from the natural resource base. In turn, this will require the adoption of sustainable intensification technologies that will bolster productivity, increase income and improve household nutrition for women and children while not deteriorating the natural resource base. Adoption of SI technologies will enhance resilience and adaptive capacity through reduced risks and/or increased productivity of smallholder systems. However, promoters and disseminators of SI technologies (researchers and extension agents) need to understand and properly manage issues of competing interests for natural and other household resources required for SI technologies uptake to increase the chances of adoption. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | |
| 2.1 Increase understanding of promoters and disseminators of SI technologies on competing interests for natural and household resources required for SI technologies promoted by Africa Rising | | | | | | | | | | | | | |
| 2.2 Identify and document competing interests for natural and other household resources required for SI technologies promoted by Africa Rising | | | | | | | | | | | | | |
| 2.3 Propose strategies for managing competing interests for natural and other household resources for increased adoption and continuous use of SI technologies promoted by Africa Rising | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | |
| 3.1 Are there trade-offs that need to be explored concerning competing interests for the natural and other household resources required for the successful adoption of SI technologies promoted by Africa RISING? | | | | | | | | | | | | | |
| 3.2 Which SI technologies promoted by Africa Rising have low adoption rates as a result of competing interests, for natural and other household resources, from existing production and/or livelihood systems? | | | | | | | | | | | | | |
| 3.3 To what extent will promoters’ and disseminators’ understanding and management of competing interests for resources influence the adoption and continuous use of SI technologies promoted by Africa RISING? | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | |
| * Review of project documentation to Compile and profile of SI technologies disseminated and promoted since the inception of the project * Community entry and sensitization on the sub-activity * Focus group discussions to decipher and document SI technologies disseminated and promoted at each of the communities * Focused group discussions and individual interviews to determine and document cases of conflicting claims for resources between the promoted SI technologies and already existing technologies * Participatory analysis of the nature of conflicting claims to resources to develop and pilot mitigation strategies * Participatory planning, implementation, and evaluation of mitigation strategies for managing conflicting claims to resources * Develop and publish a checklist of competing claims | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | | | Responsibility | |
| Is the collected data part of a multi-year experiment/trial? Yes | | | | | | | | | | | |  | |
| 5.1 Survey Data: Data on competing claims for natural and other resources within the community and the landscape | | | | | | | | | | | | Iddrisu Yahaya (SARI) | |
| 5.2 Domains of extrapolation for strategies (Dec. 2021) | | | | | | | | | | | | Alhassan Lansah Abdulai (SARI) | |
|  | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | Date of Delivery | |
| 6.1 Database upload from the survey data | | | | | | | Dataverse | | | | | Feb. 2022 | |
| 6.2. Revised analysis report on competing interests for natural, and other resources of farmers to include those posed by community and landscape levels of scale | | | | | | | Project report to be published in CGSpace | | | | | Feb. 2022 | |
| 6.3 Proposed strategies for managing competing interests for natural and other resources revised to address community and landscape-level issues | | | | | | | Proposed strategies to be published on CG Space | | | | | Oct. 2021 | |
| 6.4 Revised recommendations for managing competing interests for natural and other resources to reflect community and landscape issues | | | | | | | Project report to be published in CGSpace, One Factsheets, and one leaflet on understanding and managing competing interests for resources developed | | | | | Feb. 2022 | |
| 6.5 Focus Group discussions on insights from conflicts arising from community and landscape levels | | | | | | | Activity report on three Field visits to NR, UER, UWR communities. Semi-Annual Project Report | | | | | Jan. 2022 | |
| 6.6 Domains of extrapolation for strategies | | | | | | |  | | | | | Dec. 2021 | |
| 6.7 Data analysis and preparation of one peer-reviewed publication on ‘Effective handling of competing interests for resources to enhance adoption and use of SI technologies | | | | | | | Link to publications, policy brief, and leaflets | | | | | Jun. 2022 | |
| 6.8 Contribution to WA handbook | | | | | | | Final chapter submitted | | | | | Mar. 2022 | |
|  | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | |
| Domain | Indicators | | | | | Metric & Scale | | Approach used in data collection | | | Before intervention | | After intervention |
| 7.1 Productivity | NA | | | | | NA | | NA | | | NA | | NA |
| 7.2 Environmental | NA | | | | | NA | | NA | | | NA | | NA |
| 7.3 Economic | NA | | | | | NA | | NA | | | NA | | NA |
| 7.4 Social | Collective action  Social Cohesion | | | | | -Incidence of conflicts related to collective action at the household/ community/landscape scale  Participation in social groups at the community/landscape scale | | Focus group discussion and individual interviews  Focus group discussion and individual interviews | | | zero  worked as individuals | | Every beneficiary and most of the non-beneficiaries participate in communal assignments  Everyone thrives to participate |
| 7.5 Human | Capacity to experiment  Food security | | | | | -# of new practices being tested at the community/landscape scale and teasing out if the technologies being promoted enhance innovation and cohesion  Months of food insecurity | | Focus group discussion and individual interviews  Survey (Individual interviews) | | | Nil | | All the SI interventions being promoted by Africa RISING project |
|  | | | | | | | | | | | | | |

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| 8. How will scaling be achieved? |
| The study will be conducted in nine Africa RISINGProject communities (three from each of Northern, Upper East, and Upper West regions). Through community focus group discussions farmers are expected to participate and share information amongst themselves but will also share this information beyond their peers in the community and these will serve as vehicles for dissemination. In addition, there will be a collaboration with agricultural extension agents from the departments of Agriculture of the Metropolitan Municipal and District Assemblies (MMDAs) who in turn have a wider reach to other farmers beyond the project target communities. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| This activity links to a previous study on work conducted by STEPRI relating to constraints limiting the adoption of SI innovation as a result of the policy. Hence this study will explore potential synergies with the aforementioned activity. Since this study is focusing on competing interests for resources that could potentially hinder the adoption of SI innovations, it will implicitly link to all the project activities. This is because AR strives to ensure that technologies that are being promoted by the project are adopted by the end-users. |
|  |
| 10. Custom indicators |
| * 2 technical reports of project key achievements and results submitted * 1 Data tool manual developed for FGDs revised to include community and landscape dimensions * 1 technical leaflet that address issues of conflicting interests for resources use at community level * 2 fact sheets developed on the checklist of competing interests at landscape levels * 300 farmers trained on climate and natural resource use efficiency * Technical Report of 6 FGD presented * One peer-reviewed Journal article processed and published * Activity reports are captured in the 2022 CSIR-SARI bi-annual Report |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  Promoters’ understanding and proper management of competing interests for natural and other household resources that are needed for SI technologies, during the dissemination process, will increase chances of adoption. We anticipate that promoters’ understanding of the competing interests will allow for a better design of strategies that will eliminate or minimize the effect of the competing claims. Chances of adoption will increase if these strategies are included in the package for dissemination. This will lighten the burden of decision-making amongst target beneficiaries, there are numerous trade-offs that farmers are faced with in their day-to-day activities. Therefore, we anticipate that this process will allow for the adoption of SI technologies to enhance resilience and adaptive capacity through reduced risks and/or increased productivity. It will also minimize the risk of climate change and contributes to increasing crop productivity in the area. Increased productivity can contribute to a profitable crop enterprise thereby improving household income. |
| 11.2 Who is your target audience, e.g. extension agents, farmers, or policymakers?  Farmers, extension agents, and policymakers |
| The primary beneficiaries include crop farmers, livestock farmers, extension agents, researchers, or promoters of the SI interventions |

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| --- | --- |
| 12. Budget (US$) |  |
| Budget Line | CSIR-SARI |
| Personnel | 2,000 |
| Services | 1,000 |
| Supplies | 1,000 |
| Capital | 0 |
| Travel | 3,000 |
| Overhead | 1,050 |
| Total | 8,050 |

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| 13. Gantt chart | | | | | | | | | |
| Year/ month | 2021 | | | | 2022 | | | | |
| Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May |
| Tool development |  |  |  |  |  |  |  |  |  |
| FGD and individual survey on competing interests at community and landscape level |  |  |  |  |  |  |  |  |  |
| Compile and clean Data |  |  |  |  |  |  |  |  |  |
| Analysis of Data |  |  |  |  |  |  |  |  |  |
| Write Reports |  |  |  |  |  |  |  |  |  |
| Participatory planning, implementation & evaluation of mitigation strategies |  |  |  |  |  |  |  |  |  |
| Draft and finalize Publication |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 1: GH1112-21** | | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable and sustainably intensified crop-livestock systems linked to markets. | | | | | | | | | | | | | | |
| a. Output 4.4 | | | Knowledge sharing centers (physical structures) and learning alliances are developed within existing local and regional institutions | | | | | | | | | | | |
| b. Activity 4.4.1 | | | Establish knowledge-sharing and learning alliances among scaling actors. | | | | | | | | | | | |
| c. Sub-activity GH4411-21 | | | Scaling of Africa RISING crop-livestock technologies beyond the intervention sites in northern Ghana: The Innovation Research Extension Advisory Coordination Hubs (i-REACH) model | | | | | | | | | | | |
|  | | |  | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | |
| Name | | | | | Institution | | | | Role | | | | | |
| Fred Kizito | | | | | IITA | | | | Co-ordinator | | | | | |
| Abdul Rahman Nurudeen | | | | | IITA | | | | Demonstration of agronomic technologies | | | | | |
| Sadat Salifu | | | | | ARI | | | | Demonstration of improve feeding troughs | | | | | |
| Addah Weseh | | | | | UDS | | | | Demonstration of maize leaf strip feeding | | | | | |
| Benedict Boyubie | | | | | IITA | | | | Uploading of data onto PMMT and Dataverse | | | | | |
|  | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | | Degree | | | Start | End |
| NIL | | | |  | | | | | |  | | |  |  |
|  | | | | | | | | | | | | | | |
| f. Location(s) | | Northern (Doku) and Upper East (MoFA office, Navrongo) | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| g. Start | | June 2021 | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| h. End | | August 2022 | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | |
| Africa RISING evaluated and validated sustainable intensification technologies for cereal-legume-livestock farming system in Guinea and Sudan of northern Ghana during the phase II of the project (2016-2021). Africa RISING in collaboration with the Ministry of Food and Agriculture (MoFA) in Ghana would establish Innovation Research Extension Advisory Coordination Hubs (i-REACH) in the Northern and Upper East regions of Ghana as a knowledge sharing and learning hub to demonstrate all cereal-legume-livestock technologies validated during phase II of the project. The purpose of the i-REACH is to help disseminate Africa RISING technologies beyond the intervention communities and to ensure sustainability of technologies by handing over the technologies and hub to MoFA. Africa RISING technologies to be demonstrated in the i-REACH hubs include: Maize-legume strip cropping, optimum plant density for sustainable intensification of groundnut, maize leaf stripping, cowpea living mulch, NPK fertilizer type and management for sustainable intensification of maize and improved livestock feeding troughs. The i-REACH concept links to efforts conducted by the Sustainable Intensification Innovation Lab. | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | |
| 2.1 Disseminate Africa RISING technologies beyond Africa RISING intervention communities in northern Ghana | | | | | | | | | | | | | | |
| 2.2 Evaluate preferences of participants during field days for the technologies in the i-REACH | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | |
| 3.1 How would the use of i-REACH help in disseminating African RISING technologies beyond the intervention communities? | | | | | | | | | | | | | | |
| 3.2 What be the gender preferences for technologies in the i-REACH? | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | |
| i-REACH hubs would be established at Duko community in Northern Region and MoFA office in Upper East Region as a knowledge sharing and learning hub. Technologies in the i-REACH hubs include: Maize-legume strip cropping, optimum plant density for sustainable intensification of groundnut, maize leaf stripping, cowpea living mulch, NPK fertilizer type and management for sustainable intensification of maize and improved livestock feeding troughs. Field days would be conducted to assess the preferences of participants for the technologies and number of participants reach out to with the technologies in the i-REACH hubs. | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded | | | | | | | | | | | | Responsibility | | |
| 5.1 Number of participants reach out to with technologies in i-REACH | | | | | | | | | | | | Nurudeen Abdul Rahman/ IITA | | |
| 5.2 Gender preferences for technologies in i-REACH | | | | | | | | | | | | Bekele Kotu/ IITA | | |
|  | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | | End date | |
| 6.1 Data on number farmers reach out to with i-REACH | | | | | | | Bi-annual technical report | | | | | | Mar 2022 | |
| 6.2 Data on gender preferences for technologies in i-REACH | | | | | | | Bi-annual technical report | | | | | | Mar 2022 | |
|  | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | |
| Domain | Indicators | | | | | Metric & Scale | | Approach used in data collection | | | Before intervention | | | After intervention |
| 7.1 Productivity | -Grain yield | | | | | Field/plot | | Field measurement | | | Control yield | | | 5-10% increment for new technology |
| 7.2 Environmental |  | | | | |  | |  | | |  | | |  |
| 7.3 Economic | -Net income | | | | | Field/plot | | Survey & productivity measurement | | | Control net-income | | | 5-10% increment for new technology |
| 7.4 Social | -Technology rating by gender | | | | | Field/plot | | Survey | | | Technology rating for control | | | 5-10% increment for new technology |
| 7.5 Human | Calorie | | | | | Field/plot | | Lookup table & productivity measurement | | | Control calorie | | | 5-10% increment for new technology |
|  | | | | | | | | | | | | | | |

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| 8. How will scaling be achieved? |
| Scaling will be achieved through strategic partnerships MoFA, NARS and other NGO’s. Knowledge transfer and scaling strategies will be through the establishment of i-REACH to demonstrate technologies; participatory and joint learning approaches for evaluating technologies. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| This sub-activity is linked with the following sub-activities: GH1112-21, GH1121-21 and GH3211-21 |
|  |
| 10. Custom indicators |
| Project bi-annual report |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  Food insecurity, natural resource management, and climate change adaptation.  This sub-activity will address the following major development challenges: Increase stakeholders’ knowledge and capacity to adapt to climate change effect on crop-livestock farming systems for improved productivity per unit area or heard to address food insecurity. Increased productivity can also contribute to a profitable crop-livestock enterprise thereby improving household income. |
| 11.2 Who is your target audience, e.g. extension agents, farmers, or policymakers?  Farmers, extension agents, and policymakers |

|  |  |
| --- | --- |
| 12. Budget (US$) | IITA |
| Personnel | 38,000 |
| Services | 5,000 |
| Supplies | 4,000 |
| Capital |  |
| Travel | 2,000 |
| Overhead |  |
| Total | 49,000 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 13. Gantt Chart | | | | | | | | | | | | | | |
| Year/ Month | 2021 | | | | | | 2022 | | | | | | | |
| Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | July | Aug |
| Acquisition of inputs |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Field establishment |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Field days |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Harvest data |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Data processing and analysis |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Semi-annual report |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Ghana consolidated budget 2021-2022 (US$)**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sub-activity** | **Leader** | **IITA** | **ARI** | **IWMI** | **UDS-FA** | **WorldVeg** | **WUR** | **STEPRI** | **UDS-SH** | **KNUST** | **SARI** | **Total** |
| GH1111-21: Follow-up on gender evaluation of cowpea living mulch intervention | IITA | 0 |  |  |  |  |  |  |  |  |  | 0 |
| GH1112-21: Optimizing on-farm nitrogen (N) fertilizer use efficiency under rainfed conditions | IITA | 79,000 |  |  |  |  |  |  |  |  |  | 79,000 |
| GH1113-21: Assessing the potential for a combination of local Napier fodder species and pigeon peas for improved soil health, ruminant productivity and market potential of both Napier and Pigeon pea fodder in the Guinea savannah zone; and Investigating opportunities and constraints for fodder cultivation and trade (Napier and Pigeon pea), specifically women’s and youth market participation in this part of the livestock value chain. | UDS-FA | 6,000 |  |  | 21,850 |  |  |  |  |  |  | 27,850 |
| GH1115-21: Identification of varieties of vegetable crop species with adaptation to Northern Ghana in the dry season | WorldVeg |  |  |  |  | 64,644 |  |  |  |  |  | 64,644 |
| GH1116-21: Yield and post-harvest quality of vegetables as affected by improved soil and water management practices in the dry season Northern Ghana (Niangua, Tekuru, Bonia) | WorldVeg |  |  |  |  | 15,000 |  |  |  |  |  | 15,000 |
| GH1121-21: Efficient feed utilization through improved feed troughs | CSIR-ARI |  | 20,000 |  |  |  |  |  |  |  |  | 20,000 |
| GH1121-20: Synthesize previous work on feed and health interventions for improved small ruminant production in Northern Ghana | CSIR-ARI |  | 5,000 |  |  |  |  |  |  |  |  | 5,000 |
| GH1123-21: Assess the effect of feeding maize leaf stripping on digestibility and growth performance of small ruminants and interactions of the technology with child labor (more specifically herding of small ruminants) and school attendance of boys and girls | UDS-FA |  |  |  | 29,210 |  |  |  |  |  |  | 29,210 |
| GH1212-21: Assess the impact of soil and water conservation interventions in maize-cowpea living mulch | KNUST | 4,000 |  |  |  |  |  |  |  | 15,860 |  | 19,860 |
| GH1221-21: Evaluate the technical and agronomic performance of Bhungroo and solar energy drip irrigation system in the Upper of Ghana | IWMI |  |  | 102,337 |  |  |  |  |  |  |  | 120,664 |
| GH1411-21: Produce regionally relevant extrapolation domain maps for validated integrated technology packages. | IITA | 24,547 |  |  |  |  |  |  |  |  |  | 24,547 |
| GH1412-21: Identify the sustainable agricultural intensification technologies and household characteristics that determine the maize grain yields at the different technology extrapolation domains. | IITA | 7,000 |  |  |  |  |  |  |  |  |  | 7,000 |
| ***Sub-total Outcome 1*** |  | *120,547* | *25,000* | *102,337* | *51,060* | *79,644* | *0* | *0* | *0* | *15,860* | *0* | 394,448 |
| GH2121-20: Container gardening training combined with nutrition education for increased vegetable consumption | UDS-SH |  |  |  |  |  |  |  | 15,525 |  |  | 15,525 |
| GH2122-20: Engaging Men to Increase Support for Optimal Child Feeding Practices Using Care Group Approach | UDS-SH |  |  |  |  |  |  |  | 8,625 |  |  | 8,625 |
| GH2211-20: Evaluate the threshing efficiency of different maize shellers with regards to grain quality characteristics as influenced by different varieties and harvest timing | SARI |  |  |  |  |  |  |  |  |  | 15,009 | 15,009 |
| ***Sub-total Outcome 2*** |  | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *24,150* | *0* | *15,009* | *39,159* |
| GH 3111-21: Strengthen the technical, managerial and organizational capacities of the major actors in small ruminants value chain through existent institutional structures such as Farmer-Based Organizations (FBO), District Assemblies (DA), Community Based Organizations (CBO), traders Associations, Transports and input Dealers Association | ARI |  | 30,851 |  |  |  |  |  |  |  |  | 30,851 |
| GH3112-21: Analyze the enabling environment including policies and institutional arrangements and intervention to identify factors that enable the inclusion of women and youth along irrigated vegetable value chain | IWMI |  |  | 9,599 |  |  |  |  |  |  |  | 9,599 |
| GH3121-21: Assessing the inclusiveness of women and youth within the vegetable production value chain to enhance vegetable production among small holder farmers. | WorldVeg |  |  |  |  | 21,276 |  |  |  |  |  | 21,276 |
| GH3122-21: Assess women and the youth participation in maize and small ruminant value chains in project communities and markets the communities are linked to | IITA | 6,820 |  |  |  |  |  |  |  |  |  | 6,820 |
| GH3212-21: Co-identify value chain-based scaling pathways for irrigation technologies and water solutions with farmers and other actors of vegetable value chains in the Africa RISING sites in Mali and Ghana and link these sites and activities to ILSSI’s multi-stakeholder Dialogue Space on small scale irrigation in Ghana | IWMI |  |  | 77,631 |  |  |  |  |  |  |  | 77,631 |
| GH3213-21: Sustainable agricultural intensification, resilience capacity, and food security among smallholder farmers | IITA | 12,000 |  |  |  |  |  |  |  |  |  | 12,000 |
| ***Sub-total Outcome 3*** |  | *18,820* | *30,851* | *87,230* | *0* | *21,276* | *0* | *0* | *0* | *0* | *0* | *158,177* |
| GH4111-21: Conduct simulation and other socio-economic analyses of selected SI technologies/ practices for different farmer contexts, to have a better understanding of the adoption potential of these proven technologies and opportunities for scaling up | STEPRI |  |  |  |  |  |  | 48,300 |  |  |  | 48,300 |
| GH4112-21: Evaluate the impact of SI practices on household welfare, poverty, perceived shock, the environment, and food and nutrition security in northern Ghana | IITA | 12,000 |  |  |  |  |  |  |  |  |  | 12,000 |
| GH4113-21: Provide safety nets to smallholder farmers through crop insurance while developing a business model with multi-stakeholder partners for scaling validated technologies for equity and empowerment | IITA | 23,000 |  |  |  |  |  |  |  |  |  | 23,000 |
| GH4115-21: The impact of smallholder Agricultural commercialization on household income and nutrition in Ghana and Malawi | IITA | 12,000 |  |  |  |  |  |  |  |  |  |  |
| GH4121-21: Utilize ICT and GIS tools as a means to share information (agronomic, climatic and market services) and scale-out Africa RISING technologies in collaboration with strategic partnerships in the region | KNUST | 45,593\* |  |  |  |  |  |  |  |  |  | 45,593 |
| GH4122-20: Promotion and dissemination of Africa RISING SI interventions for sustained productivity and reduced risk in Ghana using the climate-smart village approach | SARI |  |  |  |  |  |  |  |  |  | 17,745 | 17,745 |
| GH4311-20: Matching agricultural technologies to farmers and their context | WUR |  |  |  |  |  | 0 |  |  |  |  | 0 |
| GH4312-20: Investigate the distribution of benefits from diverse agricultural interventions | WUR |  |  |  |  |  | 0 |  |  |  |  | 0 |
| GH4313-20: Addressing constraints limiting adoption of SI technologies as a result of competing interests for natural and other household resources | SARI |  |  |  |  |  |  |  |  |  | *8,050* | 8,050 |
| GH4411-21: Scaling of Africa RISING crop-livestock technologies beyond the intervention sites in northern Ghana: The Innovation Research Extension Advisory Coordination Hubs (i-REACH) model | IITA | 49,000 |  |  |  |  |  |  |  |  |  | 49,000 |
| ***Sub-total Outcome 4*** |  | *141,593* | *0* | *0* | *0* | *0* | *0* | *48,300* | *0* | *0* | *25,795* | 215,688 |
| **Grand total** |  | ***280,960*** | ***55,851*** | ***189,567*** | ***51,060*** | ***100,920*** | ***0\**** | ***48,300*** | ***24,150*** | ***15,860*** | ***40,804*** | ***807,472*** |

\*7,585 IITA, 12,593 ESOKO, 25,415 Alliance Bioversity-CIAT

\*\*WUR uses funds carried forward from previous years

## Mali Planned work

The planned activities are presented in the protocols. Activities under each protocol are aimed at achieving the outputs under the four outcomes in the project logframe (Table 3).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Africa RISING West Africa Activity Protocol – Outcome 1: MA1111-21** | | | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | | | | |
| a. Output 1.1 | | | Research products for more productive, intensive, diverse, profitable and resilient crops (cereals, legumes, vegetables), livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities | | | | | | | | | | | | |
| b. Activity 1.1.1 | | | Test a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production | | | | | | | | | | | | |
| c. Sub-activity MA1111-21 | | | Evaluate crop simulation models using different fertility sources and climate model outputs to improve the productivity of sorghum | | | | | | | | | | | | |
|  | | |  | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | | |
| Name | | | | | Institution | | | | Role | | | | | | |
| Birhanu Zemadim | | | | | ICRISAT | | | | Activity leader | | | | | | |
| Akinseye Folorunso Mathew | | | | | ICRISAT | | | | Scientist, Agronomy & Agroclimatology, assessment of productivity technology and data analysis | | | | | | |
| Bouba Traore | | | | | ICRISAT | | | | Farming Systems Scientist contributing to guidance on soil fertility research of the sub-activity | | | | | | |
| Oumar Samake | | | | | AMEDD | | | | Community mobilization for technology validation and multi-stakeholder interest group participation during a farmers field day in Koutiala | | | | | | |
| Mahamadou Dicko | | | | | AMEDD | | | | On-farm technology implementation in Koutiala | | | | | | |
| Toumani Sidibe | | | | | FENABE | | | | Community mobilization for technology validation and multi-stakeholder interest group participation during a farmers field day in Bougouni | | | | | | |
| Karamako Sanogo | | | | | ICRISAT | | | | Scientific Officer monitoring activities with development partners and farmers | | | | | | |
| Benedict Boyubie | | | | | IITA | | | | Monitoring and evaluation/data management | | | | | | |
|  | | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | | Degree | | | Start | End | |
| NIL | | | |  | | | | | |  | | |  |  | |
|  | | | | | | | | | | | | | | | |
| f. Location(s) | | Koutiala and Bougouni | | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | | |
| g. Start | | April 2017 | | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | | |
| h. End | | June 2022 | | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | | |
| Studies have shown that optimum productivity in crops may not be achieved without appropriate fertility management (Traore et al., 2014[[81]](#footnote-82); Akinseye et al., 2016 [[82]](#footnote-83)). In the Sudanian region of Mali, where sorghum is an important crop for both food and animal feed, inorganic fertilizer use is limited due to high costs, access constraints, and limited soil moisture availability. However, with large available organic resources from livestock and poultry manure, the study is evaluating different fertilizer response scenarios which combine both organic and inorganic sources across the rainfall gradient of Mali. The main target is to study whether the proposed technologies will increase grain and biomass productivity and profitability for smallholder farmers. To achieve the set target, experiments were conducted between 2017 and 2019 under different fertility management sources in the three locations across different agro-ecologies (Guinea Savanna, Sudan savanna, and Sudano-Sahelian zone), the preliminary analysis revealed the potential fertility treatment combinations plus sorghum cultivars that led to higher productivity, agronomic efficiency, and profitability. However, the potential fertilization options will be evaluated further using crop simulation models (CSMs) - APSIM or DSSAT with downscaled climate model outputs of the Coupled Model Inter-comparison Project Phase 5 (CMIP5) to assess climate change impacts on sorghum yields and evaluate marginal cost-benefit of different fertility scenarios and varieties as adaptation options to climate change. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | | |
| 2.1. To better understand physiological functioning and yield potential of three (3) improved sorghum varieties (CSM63E, CSM335, and Fadda) under different fertilizer management (livestock manure and inorganic fertilizer) across different rainfall gradients and soil characteristics | | | | | | | | | | | | | | | |
| 2.2. Estimate the residual effects of nutrients on crop and water productivity | | | | | | | | | | | | | | | |
| 2.3 Evaluate both biomass and grain yield for feed and food using the validated crop simulation models (APSIM and DSSAT) under current and future climate conditions based on observations and Global Climate Models (GCMs) output | | | | | | | | | | | | | | | |
| 2.4 Determine the marginal cost-benefit responses of different fertilizer sources based on current farming practices | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | | |
| 3.1 How can we increase sorghum productivity through optimizing fertilizer treatments (in agreement with climate-smart practices) and choosing the appropriate variety? | | | | | | | | | | | | | | | |
| 3.2 Does residual organic matter contribute to increased productivity, and how can such intensification pathways encompass environmental benefits? | | | | | | | | | | | | | | | |
| 3.3 What is the sensitivity of the current sorghum yield to climate change using high-resolution climate Models (GCMs) outputs? | | | | | | | | | | | | | | | |
| 3.4 What physiological and soil parameters are important to create suitable CSMs? | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | | |
| Following the successful completion of the experiments conducted between 2017 and 2019 across the three agro-ecological zones (Guinea Savanna, Sudan savanna, and Sudano-Sahelian zone), the analysis revealed that 5 out of 9 fertilization strategies plus two sorghum cultivars (Fadda and Soumba) were suitable for scaling. The factors for the determination of suitability included a consistent increase in productivity, agronomic efficiency of nitrogen uptake, and profitability. These treatments plus sorghum cultivars were tested on farmers’ fields during the 2020 cropping season for technology diffusion and adoption across the farming communities in Koutiala and Bougouni districts. In the 2021 cropping season, another group of farmers from the same communities will be engaged in the same experiments to capture variability in soils and rainfall patterns. A total of 40 farmers will be selected and mobilized within two districts (Koutiala and Bougouni) with the assistance of local partners (AMEDD and FENABE) for technology validation. The protocol will follow a randomized block design and the farmers’ fields will serve as replicates. Each farmer field will establish one improved sorghum variety and three (3) different fertilizer sources and farmer practices (FP) as control. The sorghum varieties include Fadda and Soumba, the fertilizer treatments will be as follows: (i) Cow manure (100g/hill), (ii) DAP 100 kg/ha + Urea(50kg/ha), (iii) DAP micro-dose (3g/hill), (iv) Cow manure (50g/hill) + poultry manure (50g/hill), and (v) Poultry manure (50g/hill) respectively. Fertilizer application will be done at sowing and 4-5 weeks after sowing. The total plot size is 20 m x 26.3m, with a total area of 526 m2, and will be divided into 4 equal parts of (8) rows each. Each treatment plot contains 8 rows (20 m x 6m). | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | | Responsibility | | | | |
| Is the collected data part of a multi-year experiment/trial? Yes | | | | | | | | | | |  | | | | |
| 5.1. Agronomic (grain and stover yields) and soil data at farm level | | | | | | | | | | | Karamoko Sanogo /ICRISAT Gilbert Dembele /AMEDD Toumani Sidibe /FENABE | | | | |
| 5.2. Economic data: cost of seed, fertilizer, cow/poultry manure, and labor | | | | | | | | | | | Karamoko Sanogo /ICRISAT Gilbert Dembele /AMEDD Toumani Sidibe /FENABE | | | | |
| 5.3. Number (gender sensitive) of farmers participating in field day | | | | | | | | | | | Karamoko Sanogo /ICRISAT Gilbert Dembele /AMEDD Toumani Sidibe /FENABE | | | | |
|  | | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | | Delivery date | | |
| 6.1 Extension materials on improved Sorghum husbandry in form of posters and flyers both English or local language | | | | | | | Extension materials uploaded on CGSPACE | | | | | | Delivered and uploaded <https://www.slideshare.net/africa-rising/2305-249618456> | | |
| 6.2 Report on good agronomic practices (GAPS) for higher productivity based on farmer field demonstration | | | | | | | Report included in the Africa RISING technical report submitted to IITA | | | | | | Jun. 2022 | | |
| 6.3 Report on farmers field day | | | | | | | Report uploaded on CGSPACE | | | | | | Feb. 2022 | | |
| 6.4 Manuscript on fertilization management strategies for smallholder sorghum production systems in Sudanian Mali: yield and profitability variability | | | | | | | Manuscript published in Agronomic Journal | | | | | | Feb. 2022 | | |
| 6.5 A report on simulating potential yield of sorghum using different fertilization strategies and future climate scenarios | | | | | | | Report included in the Africa RISING technical report submitted to IITA | | | | | | Mar. 2022 | | |
| 6.6 Conference paper on CSMs for different fertility management | | | | | | | Presentation at an international workshop | | | | | | May 2022 | | |
| 6.7 Contributions towards the development of the West Africa Handbook | | | | | | | Chapter draft on Technology 3: Improving Sorghum Productivity using both organic manure and inorganic fertilizer applications- a case study of micro-dosing Technology in Mali sent to the chief scientist | | | | | | Oct. 2021 | | |
|  | | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | | |
| Domain | Indicator | | | | | Metrics/Scale | | Approach used | | | | Before intervention | | | After intervention |
| 7.1 Productivity | Crop Productivity, Variability of production | | | | | Yield at plot level, above-ground biomass (t/ha) at farm level | | Field experimentation | | | | Sorghum yield varied from 750 kg/ha to 1,500 kg/ha due to low soil fertility condition | | |  |
| 7.2 Environmental | Soil chemical quality  Soil nutrients | | | | | NPK, pH, total organic matter at farm level | | Field data and laboratory | | | | Organic C content in Koutiala and Bamako were found slightly below the average value (3 –5 g/kg), while available P was below the critical level of 8 mg/kg established for cereal crops in the region. | | |  |
| 7.3 Economic | Profitability, variability of profitability | | | | | Net income at farm level, % of production sold (by crop, animal product), % of total income from agriculture at farm level | | Survey | | | | Almost 100% of cereal was used for household food sufficiency | | |  |
| 7.4 Social | Gender Equity | | | | | Farmer group work, access to information, % of labor involved in the activity, ranking of technologies at farm level, Literacy and numeracy of adults, % of men and women literate at household level | | Survey | | | | Women view the technology as having high drudgery | | |  |
| 7.5 Human | Nutrition | | | | | Sorghum grain for household food production (Calories/ha/year)  Number of new practices being tested or % of farmers intending to take on new practice | | Survey | | | | Legumes represent less than 10% of the land | | |  |
|  | | | | | | | | | | | | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 8. How will scaling be achieved? | | | | | |
| Scaling is achieved through engaging local development NGOs like AMEDD and FENABE who help promote and disseminate validated agronomic packages. | | | | | |
|  | | | | | |
| 9. How are the activities in this protocol linked to those of others? | | | | | |
| The activities in the current proposal are linked through the farming system concept. Nutrient use efficiencies on crop and crop productivity are linked to activity MA1112-21. Environmental and social benefits of sorghum varieties in different ecologies are linked to sub-activities MA1211-21 & MA1212-21. | | | | | |
|  | | | | | |
| 10. Custom indicators | | | | | |
| 10. Custom indicators   * Technical report * Number of farmers trained on improved soil and water conservation technology * Number of hectares under improved technology soil and water conservation technologies * Journal paper on fertilization management strategies for smallholder sorghum production systems in Sudanian Mali: yield and profitability variability * Extension guide material for community-wide distribution on improved Sorghum husbandry * Handbook Chapter | | | | | |
|  | | | | | |
| 11. Impact-based summary matrix | | | | | |
| 11.1 What is the development challenge you are addressing?  The regions where the activity is being implemented are constrained by low soil micronutrient content and productivity is low. In addition, water is very limited which results in food and feed shortages. This activity intends to address this issue through productivity and economic efficiencies. The modeling work helps the prediction of the long-term effect of climate variability on sorghum productivity and environmental benefits. | | | | | |
| 11.2. Who is your target audience? e.g., extension agents, farmers, or policymakers  Farmers, extension agents, researchers, and land use and climate change practitioners and NGOs (FENABE and AMEDD). | | | | | |
|  | | | | | |
| 12. Budget (US$) | | | | | |
| Outcome/Output/Activity | Sub-activity | Budget Line | ICRISAT | AMEDD | FENABE |
| Outcome 1/Output 1/Activity 1 | MA1111-21 | Personnel | 27,500 | 2,000 | 2,000 |
| Services | 10,500 | 2,000 | 2,000 |
| Supplies | 7,500 | 2,500 | 2,000 |
| Capital | 0 | 0 | 0 |
| Travel | 2,500 | 1,500 | 1,500 |
| Subtotal 1 | 48,000 | 8,000 | 8,000 |
| Overhead (10%) |  | 800 | 800 |
| Subtotal 2 | 48,000 | 8,800 | 8,800 |
| Overhead (17%) | 8,160 | 1,496 | 1,496 |
| Total | 56,160 | 10,296 | 10,296 |
| Grand Total | 76,752 | | | | |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 13. Gantt chart | | | | | | | | | | | |
| Year/month | 2021 | | | | | | 2022 | | | | |
| Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May |
| Field experimentation/Data collection |  |  |  |  |  |  |  |  |  |  |  |
| Soil sampling and analysis |  |  |  |  |  |  |  |  |  |  |  |
| Training of farmers and extension agents/distribution of extension guides flyer |  |  |  |  |  |  |  |  |  |  |  |
| Contribution/ finalizing West Africa Handbook Chapter |  |  |  |  |  |  |  |  |  |  |  |
| Technology dissemination via field day |  |  |  |  |  |  |  |  |  |  |  |
| Crop growth measurement |  |  |  |  |  |  |  |  |  |  |  |
| Crop harvest (biomass and grain) |  |  |  |  |  |  |  |  |  |  |  |
| Data analysis and reporting |  |  |  |  |  |  |  |  |  |  |  |
| Development of conference paper, manuscript & submission of technical report |  |  |  |  |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Africa RISING West Africa Activity Protocol – Outcome 1: MA1112-21** | | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | | | |
| a. Output 1.1 | | | Research products for more productive, intensive, diverse, profitable and resilient crops (cereals, legumes, vegetables), livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities | | | | | | | | | | | |
| b. Activity 1.1.1 | | | Test a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production | | | | | | | | | | | |
| c. Sub-activity MA1112-21 | | | Understanding soil fertility management in cereal cropping systems in southern Mali | | | | | | | | | | | |
|  | | |  | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | |
| Name | | | | | Institution | | | Role | | | | | | |
| Bouba Traore | | | | | ICRISAT | | | Activity leader | | | | | | |
| Birhanu Zemadim | | | | | ICRISAT | | | Activity coordinator | | | | | | |
| Felix Badolo | | | | | ICRISAT | | | Economic analysis | | | | | | |
| Benedict Boyubie | | | | | IITA | | | Monitoring and evaluation/data management | | | | | | |
|  | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | | Degree | | | Start | End |
| Moumini Guindo | | | | Ecole doctorale des sciences et technologies du Mali (EDSTM) | | | | | | PhD | | | Jan. 2019 | Jun. 2022 |
| Sery Coulibaly | | | | IPR/IFRA (Institut Polytechnique Rural de Formation et de Recherche Appliquée) | | | | | | MSc | | | Oct. 2020 | Apr. 2022 |
| Moussa Camara | | | | IPR/IFRA (Institut Polytechnique Rural de Formation et de Recherche Appliquée) | | | | | | BSc | | | Oct. 2020 | Dec. 2022 |
|  | |  | | | | | | | | | | | | |
| f. Location(s) | | Koutiala | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| g. Start | | April 2017 | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| h. End | | June 2022 | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | |
| In Mali for decades, stakeholders including farm households and scientists are increasingly recognizing soil nutrient depletion as one of the major constraints to sustainable agricultural development. Farming systems in the country are diverse due to different ecological conditions and production goals. Many complex factors are influencing the nutrient dynamics that include nutrient management, regeneration and plant protection, livestock integration, soil and water conservation, biodiversity, agricultural policies, and marketing structures. These factors either alone or combined can enhance or result in soil nutrient depletion.  Farm households are confronted with deteriorating price relations between farm inputs and outputs resulting in net exploitation of soil nutrients. Due to the prevailing poverty conditions, farm households have limited options for investment in nutrient-adding or nutrient-saving technologies. Nowadays, this situation is worsening due to climate change and variability. Climate-smart technologies such as organic manure use and micro-dosing application have been implemented by various actors to deal with soil nutrient depletion and climate change. Yet, there are unanswered questions about the durability of this system.  To address issues related to nutrient adding or nutrient-saving technologies, a series of activities were undertaken from 2018 until 2020 including (i) evaluating nutrient dynamics from farm to the field, (ii) compost and its application in a micro-dosing technology was practiced in the technology park of M’Pessoba and at farmers’ field conditions, (iii) cattle corralling to evaluate the productivity of dual-purpose sorghum as part of crop-livestock integration activity. The required data for activities (i) and (ii) have been collected and are analyzed, while for activity (iii) we still need to consolidate preliminary results through evaluation of the carry-over effect of corralling. The current workplan for the year 2021/2022 is prepared to finalize data collection and analysis and prepare a Ph.D., MSc theses, and manuscripts. | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 2. Objectives: To optimize nutrient flow and determine the efficiency of fertility management options under sorghum cropping in Mali | | | | | | | | | | | | | | |
| 2.1 Assessing nutrient flows and nutrient balance under different soil fertility conditions | | | | | | | | | | | | | | |
| 2.2 Exploring and testing promising nutrient management options under sorghum cropping | | | | | | | | | | | | | | |
| 2.3 Developing strategies for composting and improving nutrient use efficiency for sustainable soil fertility management | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | |
| 3.1 What are the determinants of soil fertility and nutrient balance under different soil fertility management conditions? | | | | | | | | | | | | | | |
| 3.2 What are the farmers’ adaptation options with regards to soil nutrient depletion conditions? To what extent livestock corralling system contributes to increasing soil fertility. What is the optimum deposit of nutrients content under the livestock corralling system? | | | | | | | | | | | | | | |
| 3.3 How can cotton stems be used as a source of diversification for composting? What are the major constraints of producing compost with cotton stems? | | | | | | | | | | | | | | |
| 3.4 What are the main constraints for composting and how can we reduce composting period? How can application techniques for compost improve soil fertility and crop productivity? | | | | | | | | | | | | | | |
| 3.5 How can composting method improve product quality (NPK content, C/N ratio) and hence soil fertility? How does variation of planting density of dual-purpose sorghum respond to the micro-dosing application of compost in the technology park and the farmers’ fields? | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | |
| Exploration of promising nutrient management options at farm level together with the farmers was started in the year 2019. This includes quantifying crop-livestock interactions through a cattle corralling system. In 2020/2021 we experimented together with 5 agro-pastoralists in the villages of Zanzoni and Sirakele and evaluated the carryover effect of the previous year, 2020. A total of 20 cattle were parked respectively for 3, 7, 10, and 15 nights in a 150 m2 (15 m x 10 m) enclosure which was used as an experimental plot. In 2021/2022, we will experiment using the dual-purpose sorghum variety (Soubatimi) with no fertilizer application and with the two planting densities (0.75\*0.30 and 0.75\*0.20) on the corralling field of 2020/2021. | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | | Responsibility/Institution | | | |
| 5.1 Soil physio-chemical analysis, Crop grain, and biomass yield, etc. | | | | | | | | | | | Moumini Guindo and Bouba Traore /ICRISAT | | | |
| 5.2 For chemical characterization: pH (1: 2.5 H2O), Total organic carbon, total NPK, calcium, magnesium, C/N ratio will be determined in the laboratory at maturation time of the compost | | | | | | | | | | | Moumini Guindo and Bouba Traore /ICRISAT | | | |
| 5.3 Crop yield across treatments, labor, economic data | | | | | | | | | | | Felix Badolo and Bouba Traore /ICRISAT | | | |
|  | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | | Delivery date | |
| 6.1 Household level nutrient flow data | | | | | | | Data uploaded on DataVerse | | | | | | Jan. 2022 | |
| 6.2 A report on modeled results on nutrient flow characterized across farm typologies | | | | | | | Report uploaded on CGSPACE | | | | | | Feb. 2022 | |
| 6.3 Methodological report on composting technology | | | | | | | Summary report included in the Africa RISING technical report submitted to IITA | | | | | | Apr. 2022 | |
| 6.4. Manuscript on integrated soil fertility management practices under different input and nutrient flow conditions | | | | | | | Manuscript submitted to Nutrient Cycling in Agroecosystems journal | | | | | | Dec. 2021 | |
| 6.5 Contributions towards development of the West Africa Handbook | | | | | | | Revised chapter on Technology 6:Heap Composting Process for soil fertility management sent to Chief scientist | | | | | | Dec. 2021 | |
|  | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | |
| Domain | Indicators | | | | | Metrics/ Scale | | | Approach used | | | Before intervention | | After intervention |
| 7.1 Productivity | Crop Productivity, Variability of production | | | | | Yield at plot level (t/ha), above-ground biomass (t/ha) at farm level | | | Field Experimentation | | | Sorghum yield varied from 750 kg/ha to 1,500 kg/ha | |  |
| 7.2 Environmental | Soil chemical quality  Soil nutrients | | | | | NPK (kg/ha), pH, total organic matter (t/ha) at farm level | | | Field data and laboratory | | | Soils are poor and acidic soil has pH below 5 | |  |
| 7.3 Economic | Profitability, variability of profitability | | | | | Net income at farm level, % of production sold (by crop, animal product), % of total income from agriculture at farm level | | | Survey | | | 100% of cotton production was sold while almost 100% of cereal was used for household food sufficiency | |  |
| 7.4 Social | Gender Equity | | | | | Farmer group work, access to information, % of labor involved in the activity, ranking of technologies at farm level, literacy and numeracy of adults, % of men and women literate at household level | | | Survey | | | Women are not involved in the corralling system | |  |
| 7.5 Human | Nutrition | | | | | Diversity of crops grown (% of all land) disaggregated by consumption versus sale at field level, capacity to learn | | | Survey | | | Legumes represent less than 10% of landmass | |  |

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| --- |
| 8. How will scaling be achieved? |
| Developed technologies will be made available for scaling through training of farmers in different villages and for extension workers. Reports, technical documents, and scientific papers developed with the activity will help to disseminate the technology widely. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| This is farming system research including soil fertility management, crop management, and socioeconomic analysis. Results can be used by other activities for further understanding of nutrient management under different soil fertility conditions. It is therefore linked to activities MA1111-21 and MA1113-21. |
|  |
| 10. Custom indicators |
| * Numbers of farmers attending the feedback meeting * Two reports from two training sessions * Manuscript submitted with a title Integrated Soil Fertility Management Practices Under Different Input and Nutrient Flow Conditions * A technology Handbook chapter on Heap Composting Process for Soil Fertility Management * One Ph.D. thesis on soil fertility management in Southern Mali * Two MSc theses |
|  |
| 11. Impact-based summary matrix |
| 11.1 This activity will address nutrient management issues under low soil fertility management as well as evaluation of the contribution of the livestock corralling system on improving soil fertility management. |
| 11.2 Who is your target audience, e.g. extension agents, farmers, or policymakers?  Extension agents, farmers, and NGO |

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| --- | --- | --- | --- | --- |
| 12. Budget (US$) | | | | |
| Outcome/Output/Activity | Sub-activity | Budget line | ICRISAT | AMEDD |
| Outcome 1/Output 1/ Activity 1 | MA1112-21 | Personnel | 22,500 | 2,000 |
| Services | 8,500 | 2,000 |
| Supplies | 13,500 | 2,500 |
| Capital | 0 | 0 |
| Travel | 5,500 | 1,500 |
| Subtotal 1 | 50,000 | 8,000 |
| Overhead |  | 8,00 |
| Subtotal 2 | 50,000 | 8,800 |
| Overhead (17%) | 8,500 | 1,496 |
|  |  | Total | 58,500 | 10,296 |
| Grand Total | 68,796 | | | |

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| 13. Gantt Chart | | | | | | | | | | |
| Year/Month | 2021 | | | | | | 2022 | | | |
| Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
| Field experiment implementation |  |  |  |  |  |  |  |  |  |  |
| Farmers’ feedback |  |  |  |  |  |  |  |  |  |  |
| Crop growth measurement |  |  |  |  |  |  |  |  |  |  |
| Crop harvest (biomass and grain) |  |  |  |  |  |  |  |  |  |  |
| Soil sampling and analysis |  |  |  |  |  |  |  |  |  |  |
| Training |  |  |  |  |  |  |  |  |  |  |
| Contribution/ finalizing West Africa Handbook Chapter |  |  |  |  |  |  |  |  |  |  |  |  |
| Data analysis and reporting, manuscript preparation |  |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 1: MA1113-21** | | | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | | | | |
| a. Output 1.1 | | | Research products for more productive, intensive, diverse, profitable and resilient crops (cereals, legumes, vegetables), livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities | | | | | | | | | | | | |
| b. Activity 1.1.1 | | | Test a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production | | | | | | | | | | | | |
| c. Sub-activity MA1113-21 | | | Testing adaptation of dual purposes sorghum hybrids to different agro-ecologies in Mali to diversify options for crop-livestock integration | | | | | | | | | | | | |
|  | | |  | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | | |
| Name | | | | | | Institution | | | | Rôle | | | | | |
| Baloua Nebie | | | | | | ICRISAT | | | | Activity leader | | | | | |
| Madina Diancoumba | | | | | | ICRISAT | | | | Postdoctoral fellow, Modeling specialist | | | | | |
| Nadine Worou | | | | | | ICRISAT | | | | Modeling specialist | | | | | |
| Felix Badolo | | | | | | ICRISAT | | | | Economic analysis | | | | | |
| Mamourou Sidibe | | | | | | ICRISAT | | | | Field activities | | | | | |
| Abdoulaye Diallo | | | | | | IER | | | | Field activities | | | | | |
| Birhanu Zemadim | | | | | | ICRISAT | | | | Activity coordinator | | | | | |
| Bougouna Sogoba | | | | | | AMEDD | | | | Farmers’ mobilization | | | | | |
| Mahamadou Dicko | | | | | | AMEDD | | | | Data collection, Farmers’ mobilization | | | | | |
| Benedict Boyubie | | | | | | IITA | | | | Monitoring and evaluation/data management | | | | | |
|  | | | | | |  | | | |  | | | | | |
| e. Student(s) | | | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | Degree | | | | Start | End | |
| Intern/to be identified | | | | IPR/IFRA Katibougou | | | | | MSC | | | | Jan. 2022 | Jun. 2022 | |
|  | | | |  | | | | |  | | | |  |  | |
| f. Location(s) | | Bamako | | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | | |
| g. Start | | April 2017 | | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | | |
| h. End | | June 2022 | | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | | |
| In Mali, sorghum and millet are used by farmers as their staple food, especially in rural areas. Since 2017, experiments have been conducted in the framework of the Africa RISING project to assess dual-purpose sorghum varieties adaptation to different agro-ecologies, farmers' preferences of dual-purpose sorghum varieties, and dual-purpose sorghum varieties response to different agronomic practices. These experiments were conducted on station (at ICRISAT research station at Samanko) as well as in Africa RISING technology parks in Koutiala (M’Pessoba, N’Golonianasso) and Bougouni (Flola, Madina). Results from the different sets of experiments allowed us to conclude that there was a production benefit associated with using improved genetic materials and integrated crop fertility management. In 2021/2022, we intend to develop knowledge products such as (1) publications targeting a wide audience comprising the scientific community, technical and extension service agents, and other stakeholders including male and female sorghum growers, and (2) a well-structured database for collaborative modeling with partners in academia. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | | |
| 2.1 Develop a summary paper on dual-purpose sorghum varieties' response to agronomic practices tested in modeling trials conducted in 2019 and 2020 – to be submitted for the Tropentag conference 2021. | | | | | | | | | | | | | | | |
| 2.2 Develop a full research paper based on the summary paper – to be submitted to Field Crops Research journal. | | | | | | | | | | | | | | | |
| 2.3 Create a database that encompasses all crop, weather, and soil dataset collected from 2019 to 2021 on station and in technological parks to be used for inter-comparison modeling in the framework of the Ph.D. work. | | | | | | | | | | | | | | | |
| 2.4 Develop a scientific paper using two years dataset on the agronomic and economic performance of dual-purpose sorghum varieties in Bougouni and Koutiala districts in Mali. | | | | | | | | | | | | | | | |
| 2.5 Contribute towards the development of the WA handbook. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | | |
| 3.1 Which of the dual-purpose sorghum hybrids are well adapted to Africa RISING targeted zones and beyond? | | | | | | | | | | | | | | | |
| 3.2 Are there stable hybrids for the two Africa RISING intervention districts in Mali, adapted to the environmental conditions and preferred by farmers or specific material is needed for each district? | | | | | | | | | | | | | | | |
| 3.3 What is the relation between farmers’ preferences and agronomic traits? | | | | | | | | | | | | | | | |
| 3.4 What economic advantage hybrids have compared to farmers’ best variety in each zone? | | | | | | | | | | | | | | | |
| 3.5 How best can crop modeling contribute to the identification of the optimum production region of farmer preferred varieties? | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | | |
| A summary paper will be submitted to the Tropentag conference on the 2 trials data collected from Samanko station in years 2019 and 2020. These trials aimed at; i) evaluating, in a field trial, the combined effects of fertilizer and sowing dates on the agronomic performance and the physiological traits (such as leaf area index; phenological stage, leaf number) of 2 dual-purpose sorghum varieties (Fadda and Soumba) in Mali and, ii) use the data collected to derive APSIM and DSSAT crop models phenology, canopy growth and final yield parameters. A poster will also be developed from the summary file that will be presented at the Tropentag conference in 2021. Afterward, the summary paper will be further developed in a more concise to get a scientific paper that could be submitted to the Field Crops Research journal. Moreover, several data have been generated from 2019 to 2020, these data encompassed soil chemical and physical properties, soil water content, daily weather records (rainfall, maximum and minimum temperature), and crop data on 2 contrasted dual-purpose sorghum varieties (phenology, plant height, leaf number and size, plant biomass across season, LAI and final grain and biomass yield). We intend to convert these datasets into APSIM and DSSAT format and load them in a well-structured database that could serve to achieve crop modeling activities. These data sets will be uploaded to the Dataverse repository. In parallel, data collected in the technological parks of Africa RISING in Koutiala (M’Pessoba, N’Golonianasso) and Bougouni (Flola, Madina) in 2017 and 2018 on dual-purpose sorghum varieties will be used to develop a manuscript to be published in a scientific journal and subsequently data will be uploaded on Dataverse. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | | Responsibility/Institution | | | | |
| Is the collected data part of a multi-year experiment/trial? Yes | | | | | | | | | | |  | | | | |
| 5.1 Tropentag summary paper and poster | | | | | | | | | | | Madina Diancoumba and Nadine Worou/ICRISAT | | | | |
| 5.2 Publication using Tropentag summary paper | | | | | | | | | | | Nadine Worou, Madina Diancoumba and Felix Badolo/ICRISAT | | | | |
| 5.3 Database to be uploaded on Dataverse | | | | | | | | | | | MSc intern, Nadine Worou and Madina Diancoumba/ICRISAT | | | | |
| 5.4 Preparation of 2 years (2017 and 2018) dataset on dual  purpose sorghum varieties | | | | | | | | | | | Baloua Nebie, Felix Badolo, Mamourou Sidibe/ICRISAT | | | | |
| 5.5 Contribution towards WA handbook | | | | | | | | | | | Baloua Nebie/ICRISAT | | | | |
|  | | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | | Delivery date | | |
| 6.1 Summary paper and poster to be submitted to Tropentag conference | | | | | | | Summary paper submitted to Tropentag conference | | | | | | Sep. 2021 | | |
| 6.2 Scientific paper to be submitted to Field Crops Research (FCR) | | | | | | | Confirmation from FCR on receipt of paper | | | | | | Feb. 2022 | | |
| 6.3 Creation of a database to be uploaded on DataVerse | | | | | | | Data uploaded on DataVerse | | | | | | Jun. 2022 | | |
| 6.4 Scientific article submitted (with 2 years data): Title Agronomic and economic values of dual-purpose sorghum varieties in Bougouni and Koutiala zones in Mali. | | | | | | | Confirmation from Agronomic Journal on receipt of the article | | | | | | May 2022 | | |
| 6.5 Finalization of the West Africa Handbook in collaboration with the co-authors as a team: (Sorghum hybrids) under chapter 1 | | | | | | | WA technology handbook | | | | | | Dec. 2021 | | |
|  | | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators and metrics | | | | | | | | | | | | | | | |
| Domain | Indicator | | | | Metrics/Scale | | | Approach used | | | | Before intervention | | | After intervention |
| 7.1 Productivity | Crop productivity | | | | Grain yield & stover yield in kg/ha at plot level | | | Field Experimentation | | | | Sorghum yield varied from 0.75 t/ha to 1.5 t/ha. Stover yield ranged from 4.5t/ha to 5.6t/ha | | | New hybrids' overall grain yield ranged from 3.6 t/ha to 5.4 t/ha  New hybrids overall fresh stover yield ranged from 22 t/ha to 25.4 t/ha |
| 7.2 Environmental | Soil chemical properties, soil nutrients | | | | NPK (mg/kg/ha), pH, total carbon (%) at farm level | | | Field data and laboratory | | | | Soils are poor and acidic soil has pH below 5. | | | Data analysis ongoing |
| 7.3 Economic | Profitability and variability of profitability | | | | Net income at farm level % of production sold (by crop) at farm level  % of total income from agriculture at farm level | | | Survey | | | | 100% of cotton production was sold while almost 100% of cereal was used for household food sufficiency. | | | Data analysis ongoing |
| 7.4 Social | Gender Equity | | | | Farmers’ rating of technology at farm level | | | Survey | | | | Farmers were only exposed to local varieties before intervention, hence had no choice for comparison. | | | Combined (men & Women) preference ranged from 48 to 70%  Men preference 38 to 72%  Women preference 51 to 73% |
| 7.5 Human | Nutrition  Food security | | | | Micronutrient (Fe/Zn) production (g/ha) at plot level; Availability of food at household level | | | Survey | | | | Low levels of micronutrient production with local variety sorghum. Insufficient availability of food with local sorghum variety | | | Grains were sampled and being proceeded for Fe and Zn analyses in Niamey using XRF machine |
|  | | | | | | | | | | | | | | | |

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| --- | --- | --- | --- |
| 8. How will scaling be achieved? | | | |
| The summary file and scientific papers that will be published will be shared with Africa RISING partners including extension services (Agriculture services and NGOs). In addition, the poster that will be presented at the Tropentag conference will also be presented at Africa RISING field days to farmers and other stakeholders. The created database will be uploaded on DataVerse and could be used for capacity building for early-career scientists who will be engaged in the modeling improvement. | | | |
|  | | | |
| 9. How are the activities in this protocol linked to those of others? | | | |
| This activity is focused on yield-increasing and crop-livestock integration (dual-purpose sorghum). It is therefore linked to sub-activity MA1212-21. | | | |
|  | | | |
| 10. Custom indicators | | | |
| * Number of improved technologies exposed to farmers appreciation (target = 4) * (Indicator 1.4) Number of stakeholders reached with innovative approaches/methods (target = farmer, extension, researchers, students, other stakeholders, policymakers) * (Indicator 2.4) Numbers of beneficiaries trained (at multiple scales: farmer, extension, researchers, students, other stakeholders, policymakers) | | | |
|  | | | |
| 11. Impact-based summary matrix | | | |
| 11.1 What is the development challenge you are addressing?  During the past years, several activities on improved sorghum varieties have been undertaken and satisfactory results were obtained. Publishing these results will inform stakeholders on the performance of varieties in particular areas and thus influence their choice and decision making.  Assessing valuable, ready-to-use datasets formodeling activity (parameterization and validation) is challenging particularly in Mali where modeling is still in the embryonic stage. Creating a database that could be accessible on request to be used can help to speed the modeling activity and to easily and quickly develop a scientific paper.  Better interactions between knowledge users and researchers need to be also approached to get more reliability of the results on cropping systems’ resilience evolvement in the future. | | | |
|  | | | |
| 11.2 Who is your target audience? e.g. extension agents, farmers, or policymakers  The target audience is male and female farmers that grow sorghum and rely on the grain for human consumption and the stover for animal feeding. The activity also targets decision-makers as the published results could influence their choice of varieties to be used and also scientists who could have access to good quality datasets. | | | |
|  | | | |
| 12. Budget (US$) | | | |
| Outcome/Output/Activity | Sub-activity | Budget line | ICRISAT |
| Outcome 1/Output 1/ Activity 1 | MA1113-21 | Personnel | 32,209 |
| Services | 8,500 |
| Supplies | 5,500 |
| Capital | 0 |
| Travel | 4,500 |
| Subtotal | 50,709 |
| Overhead (ICRISAT 17%) | 8,620 |
| Total | 59,329 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 13. Gantt chart | | | | | | | | | | | | |
| Year/Month | 2021 | | | | | | 2022 | | | | | |
| Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
| Finalizing technology Handbook chapter |  |  |  |  |  |  |  |  |  |  |  |  |
| Soil and weather data analysis and formatting |  |  |  |  |  |  |  |  |  |  |  |  |
| Variety parametrization with APSIM and DSSAT and database preparation |  |  |  |  |  |  |  |  |  |  |  |  |
| Scientific article writing and submission |  |  |  |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 1: MA1114-21** | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable, and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | | |
| a. Output 1.1 | | | Research products for more productive, intensive, diverse, profitable and resilient crops (cereals, legumes, vegetables), livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities | | | | | | | | | | |
| b. Activity 1.1.1 | | | Test a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production | | | | | | | | | | |
| c. Sub-activity MA1114-21 | | | Conduct certification trials of the disease tolerant varieties identified over the two years in Mali | | | | | | | | | | |
|  | | |  | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | |
| Name | | | | | Institution | | | | Role | | | | |
| Jean Baptiste Tignegre | | | | | WorldVeg | | | | Plant breeder, activity leader, data analysis | | | | |
| Wubetu Legesse | | | | | WorldVeg | | | | Plant protection specialist, data collection and data analysis | | | | |
| Edoh Kukom | | | | | WorldVeg | | | | Agronomist and post-harvest expert, data collection and field management | | | | |
|  | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | | Degree | | Start | End |
| Alpha Diallo | | | | University of Ouagadougou, Burkina Faso | | | | | | PhD | | 2019 | 2022 |
|  | | | |  | | | | | |  | |  |  |
|  | |  | | | | | | | | | | | |
| f. Location(s) | | Samanko,Mali | | | | | | | | | | | |
|  | |  | | | | | | | | | | | |
| g. Start | | September 2021 | | | | | | | | | | | |
|  | |  | | | | | | | | | | | |
| h. End | | May 2022 | | | | | | | | | | | |
|  | |  | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | |
| Varieties and diseases screening trials were conducted in the past years under the Africa RISING project. Diseases-tolerant, environmentally adapted tomato, okra, and onion varieties were identified and validated over past years in Mali under the Africa RISING project. Farmers and seed actors want to produce certified seeds of such varieties but this was impossible because they are not yet certified and registered in Mali and ECOWAS catalogs of varieties. Variety certification trials are a requirement to disseminate the varieties at a wider scale. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | |
| 2.1 Initiate registration of promising onion, tomato, and okra lines identified during multi-years and location trials under the Africa RISING project in Koutiala and Bougouni | | | | | | | | | | | | | |
| 2.2 Produce breeder’s seed of onion (06), tomato (05), and okra (05) varieties | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | |
| 3.1 What are the top three constraints in the vegetable value chain? | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | |
| The certification trials required two years for completion. Trials were implemented in 2021 and were visited twice by the members of the national committee in charge of the varieties’ certification. This process will require a second year for completion. This sub-activity integrates production, disease assessment and control, nutritional and postharvest assessments for different crop species, and improved varieties vs. local varieties to test or disseminate tomato, onion, and okra to select high-yielding and disease-resistant varieties with long shelf life. The field design will be randomized complete blocks with 4 replicates in Samanko research station. Data will also be collected on dry season trials following the requirements for variety homologation in the country. Only agronomic trials (VAT) are required. | | | | | | | | | | | | | |
|  | | | | | | | | | | | |  | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | | | Responsibility/Institution | |
| 5.1 Agronomic data: fruit yield, plant height, days to flowering and maturing,  fruit size, color | | | | | | | | | | | | Jean Baptiste Tignegre/ WorldVeg | |
| 5.2 Biotic data: resistance to diseases (bacteria blight, Bacteria leaf spot, virus), pests (thrips, mites, fruit borers) | | | | | | | | | | | | Wubetu Legesse/ WorldVeg | |
| 5.3 Nutrient content (Vit C, Iron) and acidity | | | | | | | | | | | | Edoh Kukom/ WorldVeg | |
|  | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | |
| Deliverables | | | | | | Means of verification | | | | | | End date | |
| 6.1 Report on high performing vegetable varieties with farmers’ preferred traits | | | | | | Summary report included in Africa RISING technical report | | | | | | May 2022 | |
| 6.2 Report on new disease-resistant tomato & pepper varieties | | | | | | Summary report included in Africa RISING technical report | | | | | | May 2022 | |
| 6.3 Report on major vegetable diseases | | | | | | Summary report included in Africa RISING technical report | | | | | | May 2022 | |
| 6.4 Report on varieties performance | | | | | | Report of the national committee for variety homologation | | | | | | Jun. 2022 | |
| 6.5 Book chapter completed | | | | | | Book chapter submitted for review | | | | | | Dec. 2021 | |
| 6.6 Article on onion stability analysis published | | | | | | Published article shared | | | | | | Mar. 2022 | |
| 6.7 30kg of breeders’ seeds of six onion varieties & 50 kg of 10 varieties of tomato, okra produced | | | | | | Summary report included in Africa RISING technical report | | | | | | May 2022 | |
|  | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | |
| Domain | Indicators | | | | | | Metrics/ Scale | Approach used | | | Before intervention | | After intervention |
| 7.1 Productivity | Crop productivity | | | | | | Fruit yield and fodder yield (Kg/ha) at farm level | Field experimentation | | | Tomato check variety yield: 10t/ha  Onion check variety: 15t/ha  Okra check variety; 1.5t/ha | |  |
| 7.2 Environmental | Diseases scores  Crop postharvest losses | | | | | | Number of species & varieties at field/plot level | Field experimentation | | | * 50% yield loss due to virus, Bacteria wilt on susceptible tomato, varieties   50% yield susceptible onion bulb yield loss at ambient temperature storage | |  |
| 7.3 Economic | N/A | | | | | |  |  | | |  | |  |
| 7.4 Social | N/A | | | | | |  |  | | |  | |  |
| 7.5 Human | Nutritional analysis of crops tested for adaptation and postharvest losses | | | | | | Nutrient content in tomato & onion under different fertilizer dose application at plot level | Nutritional component and quality analysis | | | There is no increase in the nutritional components (vitamin C, soluble solid contents) of tomatoes under control fertilizer treatment (no manure) | |  |

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| 12. Budget (US$) | | | |
| Outcome/  Output/Activity | Sub-activity | Budget line | WorldVeg |
| Outcome 1/Output 1/Activity 1 | MA1114-21-1 | Personnel | 20,000 |
| Services | 15,000 |
| Supplies | 10,500 |
| Capital | 0 |
| Travel | 2,000 |
| Sub-total | 47,500 |
| Overhead (18.1% | 8,597 |
| Total | 56,097 |
| Grand total | 56,097 |  |  |

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| 13. Gant Chart | | | | | | | | | | | | |
| Year/ month | 2021 | | | 2022 | | | | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| Planting nurseries and transplanting |  |  |  |  |  |  |  |  |  |  |  |  |
| Field preparation and Training |  |  |  |  |  |  |  |  |  |  |  |  |
| Data collection |  |  |  |  |  |  |  |  |  |  |  |  |
| Data analysis and report writing |  |  |  |  |  |  |  |  |  |  |  |  |
| First visit by the certification committee |  |  |  |  |  |  |  |  |  |  |  |  |
| Second visit by the certification committee |  |  |  |  |  |  |  |  |  |  |  |  |
| Data upload in DataVerse |  |  |  |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 1: MA1114-21** | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable, and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | | |
| a. Output 1.1 | | | | Research products for more productive, intensive, diverse, profitable and resilient crops (cereals, legumes, vegetables), livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities | | | | | | | | | |
| b. Activity 1.1.1 | | | | Test a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production | | | | | | | | | |
| c. Sub-activity MA1114-21-2 | | | | Evaluate and disseminate technologies to control vegetable pests and diseases, reduce postharvest losses, and improve human nutrition | | | | | | | | | |
|  | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | |
| Name | | | | Institution | | Role | | | | | | | |
| Wubetu Legesse | | | | WorldVeg | | Sub-activity leader: Data analysis of pests and diseases | | | | | | | |
| Jean Baptiste Tignegre | | | | WorldVeg | | Designing protocols, data analysis, and report writing | | | | | | | |
| Edoh Kukom | | | | WorldVeg | | Implementing vegetable postharvest quality evaluation as affected by pest and diseases | | | | | | | |
| Benedict Boyubie | | | | IITA | | Monitoring and evaluation/data management | | | | | | | |
|  | | | | | | | | | | | | | |
| e. Student (s) | | | | | | | | | | | | | |
| Name | | Institute | | | | | Degree | Start | | | End | | |
| Moussa Kanoute | | University of Ouagadougou, Burkina Faso | | | | | PhD | 2019 | | | 2021 | | |
| Raki Diallo | | University of Bamako, Mali | | | | | PhD | 2019 | | | 2021 | | |
|  | | | | | | | | | | | | | |
| f. Location(s) | | Koutiala and Bougouni | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| g. Start | | April 2017 | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| h. End | | March 2022 | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | |
| This activity was carried out in 2020 and 2021 in the technology parks of Bougouni and Koutiala to avail healthy products and improve income. However, due to a lack of an adequate water supply and late planting in the year 2020, yield performance remained very low in general and not suitable for over-year analysis. Therefore, conducting the trials in 2022 will avail reliable data for two years of analysis. Diseases, pests, and postharvest assessments will be implemented with farmers’ preferred vegetable varieties and species. Demonstrations on postharvest and processing technologies and diseases screening trials will be carried out in two technology parks in Bougouni and Koutiala. In each park, improved/validated vegetable varieties and local varieties (validated or improved varieties vs. adapted local variety) will be compared for disease and pest resistance. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | |
| 2.1 Introduce, evaluate, adapt, and disseminate existing disease and pest resistance management | | | | | | | | | | | | | |
| 2.2 Introduce, evaluate, adapt, and disseminate good agricultural practices for vegetable home gardens, to improve nutrition for households | | | | | | | | | | | | | |
| 2.3 Build capacity of farm families to reduce diseases and pest damages | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | |
| 3.1 Will leaf and/or fruit yield, pest, and disease resistances under adapted storage conditions of improved vegetable varieties increase significantly as compared to those of local varieties? | | | | | | | | | | | | | |
| 3.2 Is there a difference between male and female preferences of vegetable species and varieties? | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 4. Procedures | | | | | | | | | | | | | |
| For this sub-activity, two years of agronomic data were collected but the disease and pest characterization and assessment, the postharvest assessment started in 2020 and need a second year to avail two or more years’ data. These activities will be conducted in the technology parks of Bougouni and Koutiala.  This sub-activity integrates production, disease assessment and control, nutrition, gender equity, and economic research. Integrated pest management (IPM) and postharvest assessments for different crop species and improved varieties vs. local varieties will be conducted to test tomato and pepper to select high-yielding and disease-resistant varieties with long shelf life. The field design will be randomized complete blocks with 4 replicates in the technology parks combined across 2 locations (Bougouni, Koutiala). The technology parks will host the replicated trials. In addition, a nursery with 26 new tomato and 14 new pepper varieties will be established in the two parks to enable preliminary participatory selection by farmers with regards to diseases and yield performance, market, food and nutrition suitability. Two field days will be organized for knowledge sharing on IPM, and best postharvest practices. Data will also be collected on dry season trials and demonstrations. A survey will be implemented to document gender preferences for onion and vegetable cowpea. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | Responsibility/Institution | | | |
| Are the collected data part of a multi-year experiment? Yes | | | | | | | | | |  | | | |
| 5.1 Days to 50 % flowering | | | | | | | | | | Wubetu Legesse /WorldVeg | | | |
| 5.2 Number of plants bearing fruits per plot; and leaf yields | | | | | | | | | | Wubetu Legesse /WorldVeg | | | |
| 5.3 Disease and pest incidence (fungi, bacteria, virus, whiteflies, thrips, aphids, mites), new resistance sources for disease & pests screening trials on tomato and pepper | | | | | | | | | | Wubetu Legesse /WorldVeg | | | |
|  | | | | | | | | | |  | | | |
| 6. Milestones | | | | | | | | | | | | | |
| Deliverables | | | | | Means of verification | | | | | | | Delivery date | |
| 6.1 Report on high performing vegetable varieties with farmers’ preferred traits | | | | | Summary report included in Africa RISING technical report | | | | | | | May 2022 | |
| 6.2 Report on major vegetable diseases identified for Bougouni and Koutiala districts | | | | | Summary report included in Africa RISING technical report | | | | | | | May 2022 | |
| 6. 3 Report on farmers field days and participatory variety selection for disease resistance | | | | | Report uploaded on CGSPACE | | | | | | | Mar. 2022 | |
| 6.4 Report on farmers training and trial establishment | | | | | Summary report included in the Africa RISING technical report | | | | | | | Sep. 2022 | |
| 6.5 Database on vegetable diseases, pest assessment | | | | | Dataverse | | | | | | | Sep. 2022 | |
| 6.9 One manuscript on disease resistance/tolerance in Mali | | | | | Confirmation from Sustainability journal of submission of manuscripts | | | | | | | Oct. 2022 | |
|  | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators and metrics | | | | | | | | | | | | | |
| Domain | Indicator | | Metrics/Scale | | Approach used | | | | Before intervention | | | | After intervention |
| 7.1 Productivity | Crop productivity | | Fruit yield and leaf yield (kg/ha) at plot level | | Field experimentation.  Evaluate fruit weight and yield of control variety | | | | Tomato check variety yield: 10t/ha  Onion check variety: 15t/ha  Okra check variety; 1.5t/ha | | | |  |
| 7.2 Environmental | Diseases scores,  Crop postharvest losses | | Number of species and varieties at field/plot level | | Field experimentation.  Compare variety diseases & pest incidence scores vs. check | | | | 50% yield loss due to virus, Bacteria wilt on susceptible tomato, varieties  50% yield susceptible onion bulb yield loss at ambient temperature storage | | | |  |
|  | | | | | | | | | | | | | |
| 8. How will scaling be achieved? | | | | | | | | | | | | | |
| Scaling activities in 2021-2022 will include partnerships with development partners (AMEDD, FENABE, Women farmers’ associations in Koutiala and Bougouni, NARS). Knowledge transfer and scaling strategies will include the establishment of research-for-development plots to demonstrate technologies; participatory and joint learning approaches for variety selection in the community-based technology parks as well as farm fields; development by WorldVeg of training of trainers and hands-on training for farmers. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 9. How are the activities in this protocol linked to those of others? | | | | | | | | | | | | | |
| This sub-activity is an integrated approach that involves production. It is linked with sub-activity MA1114-21-1. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 10. Custom indicators | | | | | | | | | | | | | |
| * Number of farmers for whom the technology is affordable by gender * Number of farmers for whom the technology is available locally * Number of farmers with access to markets by gender | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 11. Impact-based summary matrix | | | | | | | | | | | | | |
| 11.1 What is the development challenge you are addressing?  (i) Low access to quality seeds of improved varieties, (ii) high pressure of diseases and pests without effective control methods and use of banned pesticides, (iii) high postharvest losses due to low access to affordable storage facilities, (iv) high rates of malnutrition prevailing for women and infants due to low consumption of vegetables, (iv) low access to land and markets by women, (v) weak linkage to vegetable markets. | | | | | | | | | | | | | |
| 11.2 Who is your target audience, e.g., extension agents, farmers, or policymakers?  The targeted audience is farmers, extension agents, NGOs, farmers’ associations, local community leaders, and policymakers. | | | | | | | | | | | | | |

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| 12.Budget (US$) | | | |
| Outcome/Output/  Activity | Sub-activity | Budget line item | WorldVeg |
| Outcome 1/Output 1/Activity 1 | MA1114-21-2 | Personnel | 12,000 |
| Services | 5,000 |
| Supplies | 10,000 |
| Capital |  |
| Travel | 10,000 |
| Overhead (18.2%) | 6,734 |
|  |  | Total | 43,734 |

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| 13. Gantt Chart | | | | | | | | | | | | |
| Year/Month | 2021 | | | 2022 | | | | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
| Planting nurseries and transplanting |  |  |  |  |  |  |  |  |  |  |  |  |
| Field preparation and training |  |  |  |  |  |  |  |  |  |  |  |  |
| Trial start |  |  |  |  |  |  |  |  |  |  |  |  |
| Data collection |  |  |  |  |  |  |  |  |  |  |  |  |
| Data analysis and report writing |  |  |  |  |  |  |  |  |  |  |  |  |
| Field day |  |  |  |  |  |  |  |  |  |  |  |  |
| Participatory technology selection |  |  |  |  |  |  |  |  |  |  |  |  |
| Data upload in Dataverse |  |  |  |  |  |  |  |  |  |  |  |  |
| Manuscript preparation and submission |  |  |  |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 1: MA1131-21** | | | | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | | | | | |
| a. Output 1.1 | | | Research products for more productive, intensive, diverse, profitable and resilient crops (cereals, legumes, vegetables), livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities | | | | | | | | | | | | | |
| b. Activity 1.1.3 | | | Test and disseminate integrated crop-livestock-soil systems to increase and sustain productivity and reduce risk | | | | | | | | | | | | | |
| c. Sub-activity MA1131-21 | | | Risk management and informed decision making towards sustainable intensification of crop-livestock systems | | | | | | | | | | | | | |
|  | | |  | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | | | |
| Name | | | | | | Institution | | | | | Role | | | | | |
| Katrien Descheemaeker | | | | | | Wageningen University | | | | | Activity leader, student supervisor | | | | | |
| Jeroen Groot | | | | | | Wageningen University | | | | | Activity co-leader | | | | | |
| Ken Giller | | | | | | Wageningen University | | | | | Student supervisor | | | | | |
| Birhanu Zemadim | | | | | | ICRISAT | | | | | Collaborator | | | | | |
|  | | | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | | | |
| Name | | | | | Institute | | | | | | Degree | | | Start | | End |
| Arouna Dissa | | | | | Wageningen University | | | | | | PhD | | | Jan. 2017 | | Dec. 2021 |
| Eva Huet | | | | | Wageningen University | | | | | | PhD | | | Jan. 2017 | | Dec. 2021 |
| Ken Ejiri | | | | | Wageningen University | | | | | | MSc | | | June 2021 | | Dec. 2021 |
|  | |  | | | | | | | | | | | | | | |
| f. Location(s) | | Koutiala, Mali | | | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | | | |
| g. Start | | June 2018 | | | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | | | |
| h. End | | June 2022 | | | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | | | |
| Farming in southern Mali is conducted in a risky environment, related for instance to market and weather shocks and uncertainties. Crop-livestock interventions are usually not attractive to farmers if they increase farming risk. To tailor the interventions to the risky smallholder context, we need a better understanding of farmers’ risk mitigation strategies, and how the intended interventions aggravate or mitigate risks. As risk affects different farm components and farm activities and as different household members perceive and manage risk differently, a whole-farm and gender-disaggregated analysis is needed. With crop and livestock experiments typically spanning only a few years and a limited range of biophysical conditions, dynamic models are promising tools to evaluate multi-year variability and to quantify the risk and the effects of risk mitigation options. Based on our earlier simulation analysis at field level, we now intend to integrate findings at farm level, using modern portfolio analysis to explore the risk mitigation potential of different diversification strategies.  Another major bottleneck for the adoption of SI options is farmers’ limited planning and budgeting capacity for whole-farm management. Farmers need to balance (sometimes competing) the objectives of food production and income generation under resource constraints related to capital, labor, and land. Simple tools for record-keeping, for making objectives explicit, and for budgeting farm activities, could assist farmers in taking the right strategic and tactical decisions for managing their farm. Incorporating the effects of promising crop-livestock intensification options in the decision-support tools mentioned above could help farmers to ex-ante assess the added value of their implementation. In this activity, we intend to scale the use of the tools with a wider group of farmers and extension and development agents. In parallel, we seek to analyze how the use of the tools helps farmers to adjust their farm management. | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | | | |
| 2.1 To explore the risk mitigation potential of different diversification strategies in the mixed farming systems of southern Mali | | | | | | | | | | | | | | | | |
| 2.2 To scale the use of a farm planning and budgeting tool for improved farm management. | | | | | | | | | | | | | | | | |
| 2.3 To better understand the effects of a farm planning and budgeting tool for on-farm management and performance | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | | | |
| 3.1 How do different diversification strategies affect production and yield stability at the farm level? | | | | | | | | | | | | | | | | |
| 3.2. What are the critical design criteria for a decision support tool targeting smallholder farmers? | | | | | | | | | | | | | | | | |
| 3.3 How do simple decision support tools influence farmer decision-making before, during, and after the season? | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | | | |
| 4.1 We intend to use Modern Portfolio Theory (Noordwijk et al., 1994[[83]](#footnote-84); Paut et al., 2019[[84]](#footnote-85)) with the data obtained from the earlier DSSAT crop simulation analysis that we performed with different cereal crops (maize, millet, sorghum), management settings (variety, sowing date, fertilizer levels), common soil types and long-term climate data. This will be combined with observed yield data for cotton and cowpea. Explorations will be performed for typical farms, representing four different resource endowment categories. The analysis will be conducted in R.  4.2 In the past years, a farm planning, budgeting, and monitoring tool was developed and tested with a limited number of farmers in southern Mali. Guidelines for using the tools were developed for development agents. To scale the tools for use by a larger number of farmers, we intend to organize training sessions for both farmers and development agents in the villages of the Koutiala district. The training sessions will involve farmers from different farm types. Mostly the people overseeing the activities of the family fields will be involved. These are mostly men, but women participating in family activities will also be involved in the trainings.  4.3. Detailed data on-farm management decisions and activities have been collected through our work of the past years with about 20-30 farmers from different farm types. This data will now be used for an analysis of how farmers’ decision-making is influenced by the use of the tool. The analysis will focus on farm-level indicators in the economic and food security domains of SI. | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | | | | Responsibility | | | |
| 5.1 Results from the Modern Portfolio Theory assessment | | | | | | | | | | | | | Katrien Descheemaeker/WUR | | | |
| 5.2 Data on number of participating farmers and development agents | | | | | | | | | | | | | Arouna Dissa/WUR | | | |
| 5.3 Farm records and data on farm planning and production | | | | | | | | | | | | | Arouna Dissa/WUR | | | |
|  | | | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | | | |
| Deliverables | | | | | | | | Means of verification | | | | | | Delivery date | | |
| 6.1 MSc thesis and summary report | | | | | | | | MSc thesis shared with the project, and report submitted | | | | | | Jan. 2022 | | |
| 6.2. Report on the training activities | | | | | | | | Report shared with Africa RISING project leadership | | | | | | Jun. 2022 | | |
| 6.3 Paper on farm planning and budgeting tool | | | | | | | | Submitted paper shared with Africa RISING project leadership | | | | | | Jun. 2022 | | |
| 6.4. West Africa Handbook chapters; contribution to chapters 3, 4, 9 and lead of chapter 10 | | | | | | | | Chapters ready and shared, awaiting revision | | | | | | Dec. 2021 | | |
|  | | | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | | | |
| Domain | Indicators | | | | | | Metric & Scale | | | Approach used in data collection | | Before intervention | | | | After intervention |
| 7.1 Productivity | Crop Productivity | | | | | | Crop yield (kg/ha) at farm level | | | Baseline data (Falconnier et al., 2015[[85]](#footnote-86)); Farmer records from the monitoring tool | | Cotton: 754 – 1051 kg/ha  Maize: 1298 – 2427 kg/ha  Sorghum: 650 – 1107 kg/ha  Millet: 524 – 884 kg/ha  (ranges relate to farm types, as explained in Falconnier et al., 20153) | | | |  |
| 7.3 Economic | Risk  Production variability  Income variability | | | | | | Variability in farm production, Enterprise budgets for crops ($/farm), Probability that profits are less than thresholds related to poverty and living income (%) | | | Crop modeing; Modern Portfolio Analysis (MPA) | | the “before” value is seen as the baseline value in the modeling exercise using MPA. In this analysis, “the intervention” relates to diversification, which we model with the MPA. Hence, both the “before” and the “after” value will be the result of the modeling analysis | | | |  |
| 7.5 Human | Farm management skills | | | | | | Qualitative indicators for farmers’ ability to plan, budget, keep records and evaluate performance | | | Detailed farm monitoring through the use of the decision support tools | | - No explicit expression of farmers’ objectives for food, income and fodder.  -absence of book-keeping on farm enterprises/ activities implemented.  - no assessment of farm performance | | | |  |
|  | | | | | | | | | | | | | | | | |
| 8. How will scaling be achieved? | | | | | | | | | | | | | | | | |
| Quantified effects of crop-livestock intensification and diversification options on economic indicators and risk will allow a better understanding of important constraints and bottlenecks to adoption by farmers. A disaggregated analysis, enabled by information gathered from different types of farmers and gender groups through the household surveys, will inform better tailoring of options.  The planning and budgeting tool will inform farmers about the potential effects and needed resources of SI options and practices, thus influencing farmers’ decisions on the use of these options and practices. The scaling of the tool will be enabled by the development of tool guidelines for use by extension agents and development practitioners; and by the training sessions that are planned in the coming year. The tools and the guidelines will be actively shared in wider networks and through other projects. | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 9. How are the activities in this protocol linked to those of others? | | | | | | | | | | | | | | | | |
| Firstly, methods and approaches can be shared with GH3211-21, which is also about risk management. Crop modeling is also conducted in MA1111-21, and model approaches and parameter sets can be exchanged. We can create synergies between our activity on training for the decision support tools and the activities around institutional development, such as MA4111-21 and MA4312-21. | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 10. Custom indicators | | | | | | | | | | | | | | | | |
| * 50 development agents trained on the use of the decision support tools * 300 farmers (female and male) trained on the use of the decision support tools | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 11. Impact-based summary matrix | | | | | | | | | | | | | | | | |
| 11.1 What is the development challenge you are addressing? | | | | | | | | | | | | | | | | |
| 11.2 Who is your target audience, e.g., extension agents, farmers, or policymakers?   * Farmers (training on the decision support tools and risk assessment) * Extension workers (training on the decision support tools) * Policymakers (risk assessment) | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |
| 12. Budget (US$) | | | | | | | | | | | | | | | | |
| Outcome/Output/Activity | | | | Sub-activity | | | | | Budget line | | | | | | WUR | |
| Outcome 1/Output 1/ Activity 3 | | | | MA1131-21 | | | | | Personnel | | | | | | 13,000 | |
| Services | | | | | | 2,000 | |
| Supplies | | | | | | 2,000 | |
| Capital | | | | | |  | |
| Travel | | | | | | 3,000 | |
| Subtotal1 | | | | | | 20,000 | |
| Overhead (WUR 16%) | | | | | | 3,200 | |
| Subtotal 2 | | | | | | 23,200 | |
| Overhead (ICRISAT 17%) | | | | | | 3,944 | |
| Total | | | | | | 27,144 | |

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| 13. Gant Chart | | | | | | | | | |
| Year/ Month | 2021 | | | | 2022 | | | | |
|  | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
| Data analysis risk assessment |  |  |  |  |  |  |  |  |  |
| Write-up of risk assessment |  |  |  |  |  |  |  |  |  |
| Training of trainers |  |  |  |  |  |  |  |  |  |
| Training of development agents and farmers |  |  |  |  |  |  |  |  |  |
| M&E: Farmer survey on use of the tool |  |  |  |  |  |  |  |  |  |
| Data analysis decision support tool |  |  |  |  |  |  |  |  |  |
| Write-up of decision support analysis |  |  |  |  |  |  |  |  |  |
| Handbook chapters |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 1: MA1211-21** | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | | |
| a. Output 1.2 | | | | | | Integrated management technologies and practices to improve and sustain productivity and ecosystems services of the soil, land, water and vegetation resources are developed and disseminated to farmers and development partners in the intervention communities | | | | | | | |
| b. Activity 1.2.1 | | | | | | Test and disseminate land, soil and integrated land-soil technologies and practices to improve and sustain productivity and eco-systems services at the farm and landscape/watershed levels | | | | | | | |
| c. Sub-activity MA1211-21 | | | | | | Assess cropping management factors using empirical relations, GIS and Remote Sensing tools in two agro-ecologies of Mali | | | | | | | |
|  | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | |
| Name | | | | Institution | | Role | | | | | | | |
| Birhanu Zemadim | | | | ICRISAT | | Activity leader, Land and Water Management | | | | | | | |
| Abdramane Ba | | | | USTTB | | PhD thesis advisor | | | | | | | |
| Ramadjita Tabo | | | | ICRISAT | | Review and guide the technical report | | | | | | | |
| Souleymane Sanogo | | | | USTTB | | PhD thesis co-advisor | | | | | | | |
| Kalifa Traore | | | | IER | | Contribute to technical report | | | | | | | |
| Bougouna Sogoba | | | | AMEDD | | Provide GIS and Remote Sensing data | | | | | | | |
| Mahamadou Dicko | | | | AMEDD | | Provide data on social and human well-being | | | | | | | |
| Benedict Boyubie | | | | IITA | | Monitoring and evaluation/data management | | | | | | | |
|  | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | |
| Name | | | | | Institute | | Degree | | | Start | | | End |
| Karamoko Sanogo | | | | | USTTB | | PhD | | | Jan. 2017 | | | Dec. 2021 |
|  | | | | | | | | | | | | | |
| f. Location(s) | | Koutiala and Bougouni | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| g. Start | | September 2019 | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| h. End | | December 2021 | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | |
| The semi-arid region of Mali is characterized by intensive agricultural practices, land degradation, and strong climatic variability. Soil water erosion is a major problem for agricultural productivity and monitoring erosion or soil loss becomes trivial when done at an individual and separate or non-connected farmland area as the whole landscape is prone to heavy erosion during storm events. Excessive and uncontrolled erosion is the main cause of loss of inherent soil fertility levels of N, P, K, thus leading to a decline in potential crop yields at plot or farm levels (Mahdi *et al*., 2002)[[86]](#footnote-87). Up until recently in most parts of southern Mali, sustainable land management practices focused on reducing runoff and soil loss from plot or farm level through the implementation of soil and water conservation (SWC) practices such as contour bunding. Though important in its application at plot or farm level, the efficiency of contour bunding is limited when it comes to addressing landscape vulnerability of degradation and loss of crop productivity. Excessive soil water erosion is caused by an accumulated runoff from farm fields, grazing areas or bushland or a combination of land uses and land covers. Landscape-level information on the processes of soil water erosion and water infiltration and the associated losses of plant-available nutrients are often missing in most studies. In this study determination of crop management factors that are functions of soil water loss at a landscape level are conducted. The study includes identification and mapping of erosion factors at landscape levels and aims to build model parameters by estimating the rainfall erosivity factor, the soil erodibility factor, and the topographic factors responsible for runoff generation in the watershed villages of Bougouni and Koutiala through empirical relations, GIS and Remote sensing techniques. The study will be useful in providing guided information on the importance of controlling soil erosion at a landscape level and predicting spatial distribution of plant nutrients suitable to increase crop productivity. To preserve soil and water resources, decision-makers need information on natural resources to plan suitable strategies and measures. Mapping soil erosion risk identifies vulnerable areas for environmental protection. In addition, the economic value of soil erosion can be used by the decision-makers to prioritize areas of soil conservation and integrated watershed management practices[[87]](#footnote-88). Most of the data have been collected and data is being analyzed. A technical report titled ‘Vulnerability of landscape pattern from a multidisciplinary approach based on remote sensing (RS) and geographical information system (GIS)’ has been uploaded on CGSPACE. <https://hdl.handle.net/10568/113775>. A report on household perception on land management strategies for reducing soil erosion and soil fertility improvement has been finalized and submitted to the chief scientist for his review and comment before uploading on CGSPACE. The main activity for 2021/2022 will be writing a manuscript using data collected from 2019 to 2021. Supplementary data collected in the Africa RISING project since the year 2014 will be used as well. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | |
| 2.1 Determine landscape level mean annual soil loss using empirical relations, GIS, and Remote sensing techniques. | | | | | | | | | | | | | |
| 2.2 Assess the impact of soil erosion on landscape soils productivity. | | | | | | | | | | | | | |
| 2.3 Evaluate variations of plant-available nutrients, such as carbon, nitrogen, phosphorous, and potassium in different agro-ecologies under different land-use systems | | | | | | | | | | | | | |
| 2.4 Identify areas affected by natural and anthropogenic changes | | | | | | | | | | | | | |
| 2.5 Provide appropriate guidance and recommendation on environmental protection to help increase crop productivity and reduce soil degradation | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | |
| 3.1 What is the spatial distribution of soil loss rate in southern Mali? | | | | | | | | | | | | | |
| 3.2 To what extent does soil water erosion affect smallholder rural agriculture yield? | | | | | | | | | | | | | |
| 3.3 How important are efficient landscape erosion controlling measures advantageous from the ecological and social perspectives to increase productivity and reduce poverty? | | | | | | | | | | | | | |
| 3.4 What are the most vulnerable areas in the two agro-ecological zones (Sudan Savanna and Guinea Savanna)? | | | | | | | | | | | | | |
| 3.5 How do the interventions increase resilience of communities? E.g., if intervention X is conducted, it results in Y drought-free days which equates to building resilience? | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, sample size, etc.) | | | | | | | | | | | | | |
| 4.1 This work involves the use of soil moisture data collected in phase 1 of Africa RISING project (soil moisture data is available from 2014 to 2017) to investigate the influence of erosion on soil water infiltration. Remotely sensed soil moisture data will be correlated with the ground data to provide information on landscape soil moisture information. Long-term data on rainfall amount and intensity will be used to estimate the rainfall erosivity factor. The topographic map and Digital Elevation Map from high-resolution satellite imagery will be used to determine the soil topographic factor and the soil erodibility factor. Here the GIS version of modified universal soil loss equation will be used to estimate soils topographic factors. Mapping of cropping management factors will be made at a landscape scale in the two agro-ecologies. Product maps will be produced to identify vulnerable areas at landscape level and will be communicated to land planners and national research institutes. The main activity of the work plan in 2021/2022 is finalizing the data analysis and prepare a manuscript for publication. | | | | | | | | | | | | | |
| 4.2 A survey was conducted to complete the study based on which conclusions and recommendations will be made for best management practices and is included in the proposed manuscript writeup. The survey work investigated farmers’ perception of the influence of soils, water erosions on smallholder income and the contribution of erosion to poverty and outward migration. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | Responsibility/Institution | | | | |
| Is the data collected part of a multi-year experiment? Yes | | | | | | | | |  | | | | |
| No new data is collected but will ensure that all previously collected data is uploaded on Dataverse. The list includes the following:   * Soil moisture data in Bougouni and Koutiala for the years between 2015 to 2017 * Farmers’ fields agronomic data (surface, biomass and yield etc) from 2015 to 2021 * Any data that has not been uploaded on Dataverse | | | | | | | | | ICRISAT/Karamoko Sanogo | | | | |
|  | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | Delivery status and date | |
| 6.1 Report on the vulnerability of landscape pattern from a multidisciplinary approach based on remote sensing (RS) and geographical information system (GIS) determined | | | | | | | Report uploaded on CG Space | | | | | Delivered  <https://hdl.handle.net/10568/113775> | |
| 6.2 Report on household perception on land management strategies for reducing soil erosion and soil fertility improvement | | | | | | | Report uploaded on CG Space | | | | | Report under review. submitted to the Chief scientist | |
| 6.3 Publication based on both reports | | | | | | | Confirmation from Journal of Agriculture and Food Security of article submission | | | | | Dec. 2021 | |
| 6.4 Finalization of the West Africa Handbook in collaboration with the co-authors as a team | | | | | | | Handbook revisions  Chapter 5: Strategies for Improving Land, Soil and Water Resources Management in West Africa and the Sahel | | | | | Dec. 2021 | |
|  | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators and metrics | | | | | | | | | | | | | |
| Domain | Indicator | | Metrics/scale | | | Approach used | | Before intervention | | | After intervention | | |
| 7.2 Environmental | Vegetative cover  erosion | | Percentage vegetative and tree cover (end of wet season, end of dry season) and landscape or community scale?  Erosion (t/ha/yr) (MUSLE or RUSLE) | | | GIS and remote sensing  Information | | In Bougouni, the vegetation and tree cover in 2015 was 13,830 ha (70% of the district). The data for Koutiala in 2015 is 5,530 ha (58%).  In Bougouni, the percentage of area for rate of erosion < 11 t/ha/yr was 89% in 2015.  For Koutiala, the figure was 91%. | | | In Bougouni, the vegetation and tree cover in 2019 was 13,656 ha (69% of the district). The data for Koutiala in 2019 is 5,839 ha (61%). In Bougouni, the percentage of area for rate of erosion < 11 t/ha/yr was 96% in 2019. For Koutiala the figure was 92%. | | |
| 7.4 Social | Equity (gender, marginalized group)  Level of social cohesion | | Variability and distribution of productivity, income and assets (at what scale?)  Active farmer groups  Active innovation platforms. | | | Survey | | There were no active innovation platforms before the intervention by the project in the districts of Bougouni and Koutiala. | | | In 2021, farmers reported that as a result of adopting improved technological innovations, sorghum and millet productivity increased from 38% to 58%. Net return increased by 20%.  In 2020, there were four active innovation platforms, two at the village level and two at the district level. | | |
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| 8. How will scaling be achieved? |
| Scaling is achieved through promoting the go-to landscape maps on soil loss and providing guidance on appropriate land management practices at landscape levels. Scaling is done by project partners and others in Mali who are interested in landscape management practices like CARE-Mali, WFP and UNDP. Local NGOs will be used to train the farming communities in local languages on appropriate practices to reduce land degradation. The information generated from the different agro-ecologies on the benefits of reducing soil-water losses at the landscape levels will be communicated widely through Farmer Field Days, peer to peer exchange and local radios. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| This activity is linked to most agronomic, soil fertility improvements and soil and water conservation practices proposed in the sub-activities MA1111-21, MA1112-21, MA11113-21 and MA1212-21. |
|  |
| 10. Custom indicators |
| * Percentage of land area prone to erosion * Percentage gains in productivity by applying SWC practices at landscape levels * Resilience metrics as a result of SWC interventions * Number and types of technologies implemented |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  Most of the farmlands in rural Mali are prone to erosion due to excessive rainfall within a short duration. The extent of runoff generated hasn’t been studied well at a landscape level even though well-documented information at the farm level exists widely. By determining cropping management factors areas suitable for agricultural production will be studied and communicated. Degraded and erosion hotspot areas will be mapped for proper attention by the decision-makers. |
| 11.2 Who is your target audience, e.g., extension agents, farmers, or policymakers?  Farmers in rural communities are the target groups. In addition, policymakers, land managers are the target groups. |
|  |
| 12. Budget (US$) |

|  |  |  |  |
| --- | --- | --- | --- |
| Outcome/Output/  Activity | Sub-activity | Budget line | ICRISAT |
| Outcome 1/Output 2/Activity 1 | MA1211-21 | Personnel | 38,000 |
| Services | 5,500 |
| Supplies | 4,500 |
| Capital | 0 |
| Travel | 0 |
| Sub-total | 48,000 |
| Overhead (17%) | 8,160 |
| Total | 56,160 |

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| --- | --- | --- | --- | --- | --- | --- |
| 13. Gantt Chart | | | | | | |
| Year/Month | 2021 | | | | | |
| Jul | Aug | Sep | Oct | Nov | Dec |
| Finalization of the West Africa Handbook in collaboration with the co-authors as a team |  |  |  |  |  |  |
| Finalizing the analysis of long-term data and archiving land use, land cover and soil information |  |  |  |  |  |  |
| Determination parameters for soil erodibility and erosivity |  |  |  |  |  |  |
| Classified assessment of landscape analysis |  |  |  |  |  |  |
| Scientific article writing and submission |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 1: MA1212-21** | | | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, profitable and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | | | | |
| a. Output 1.1 | Research products for more productive, intensive, diverse, profitable and resilient crops (cereals, legumes, vegetables), livestock (sheep, goats, cattle, poultry and pigs) and integrated crop-livestock farming systems are identified and disseminated to farmers through development partners in the intervention communities | | | | | | | | | | | | | | |
| b. Activity 1.1.1 | Test a combination of climate-smart crop varieties and agronomic practices to increase and sustain food and feed production | | | | | | | | | | | | | | |
| c. Sub-activity MA1212-21 | Improving crop-livestock productivity and household income through the use of contour bunding and agroforestry options | | | | | | | | | | | | | | |
|  |  | | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | | |
| Name | | | | | Institution | | | | | Role | | | | | |
| Kalifa Traoré | | | | | IER | | | | | Activity leader, protocol design, statistical analysis, reporting, defense of the PhD thesis | | | | | |
| Birhanu Zemadim | | | | | ICRISAT | | | | | Scientific support | | | | | |
| Oumar Samake | | | | | IER | | | | | Research assistant | | | | | |
| Benedict Boyubie | | | | | IITA | | | | | Monitoring and evaluation/data management | | | | | |
|  | | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | | |
| Name | | | | Institute | | | | | | | Degree | | Start | | End |
| Cheick Oumar Dembele | | | | USTTB (Bamako) | | | | | | | PhD | | 2017 | | 2022 |
|  | | | |  | | | | | | |  | |  | |  |
|  | |  | | | | | | | | | | | | | |
| f. Location(s) | | M’Pessoba, Kani, Noumpinesso and Zebala (Koutiala district) | | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | | |
| g. Start | | March 2017 | | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | | |
| h. End | | June 2022 | | | | | | | | | | | | | |
|  | |  | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | | |
| Additional data is required to reinforce data accuracy on micro-dosing and its impact on soybean intercropped with sorghum under contour bunding technology and manuscript writing. Training in nursery implementation and management is a key element for the sustainability of the technology. As a result, there will be a need to create a support program for farmers to upscale the agroforestry-based business model and contour bunding combined with fast-growing trees species as a pathway for preliminary adoption. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | | |
| 2.1 Training farmers on nursery-based agroforestry using fodder trees | | | | | | | | | | | | | | | |
| 2.2 Continuation of implementation of contour bunding demonstration plots and training sessions | | | | | | | | | | | | | | | |
| 2.3 Continuation of implementation of intercropping sorghum-soybean in demonstration plots for women | | | | | | | | | | | | | | | |
| 2.4 Organize farmer exchange visits to encourage peer to peer learning among collaborating farmers and newcomers (seeing is believing) | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | | |
| 3.1: Does the training of farmers on nursery implementation enhance fodder production and create a business model for promotion of this technology? | | | | | | | | | | | | | | | |
| 3.2: Is the implementation of contour bunding demonstration plots a better strategy for upscaling the technology of sorghum-soybean intercropping in the study area? | | | | | | | | | | | | | | | |
| 3.3: What is the profitability of intercropping sorghum-soybean in the contour bunding system? | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 4. Procedures (Farmers exchange visit, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | | |
| Sole crops of soybean and sorghum will be compared to the intercropping system in 5 farmer’s fields, each farmer being a replication. DAP fertilizer will be used in micro-dosing (50 kg ha-1 instead of 200 kg as recommended) on soybean. Farmer exchange visits including neighboring villages will be organized in October 2021. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | | | | Responsibility/Institution | | |
| 5.1 Sorghum and soybean growth, yields, and profitability using intercropping system | | | | | | | | | | | | | Oumar Samake/IER | | |
| 5.2 Farmer exchange visit | | | | | | | | | | | | | Kalifa Traore and Oumar Samake/IER | | |
|  | | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | | Delivery date | | |
| 6.1 Report on farmers training on nursery based agroforestry using fodder trees | | | | | | | Summary report included in the technical report to IITA | | | | | | Mar. 2022 | | |
| 6.2 Report on establishment of contour bunding demonstration plots | | | | | | | Summary report included in the technical report to IITA | | | | | | May 2022 | | |
| 6.3 Database on sorghum-soybean intercropping | | | | | | | Data uploaded on Dataverse | | | | | | May 2022 | | |
| 6.4 Farmer exchange visit | | | | | | | Summary report included in the technical report to IITA | | | | | | Oct. 2021 | | |
| 6.5 Journal article | | | | | | | Copy of the article uploaded | | | | | | Nov. 2021 | | |
| 6.6 Ph.D. thesis | | | | | | | PDF copy of Ph.D. thesis uploaded on CG Space | | | | | | Dec. 2021 | | |
|  | | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | | |
| Domain | Indicators | | | | | Metrics/Scale | | | Approach used | | | Before intervention | | | After intervention |
| 7.1 Productivity | Crop productivity  Input use efficiency  Cropping intensity | | | | | Yield (kg/ha) at farm level  # of cropping seasons per year at farm level | | | Experimentation | | | Yield of the main cereal crop (sorghum) from 750 kg/ha to 1500 kg/ha | | |  |
| 7.2 Environmental | Soil chemical properties, Soil fertility | | | | | NPK, pH, OM at plot level | | | Field and laboratory | | | Low organic C content, and low values of N, below the average value (3 –5 g/kg), while available P was below the critical level of 8 mg/kg established for cereal crops in the region. | | |  |
| 7.3 Economic | Profitability, variability of profitability | | | | | Farm-level cost-benefit analysis to determine the best fertilizer scenarios. | | | Survey | | | Almost 100% of cereal was used for household food sufficiency. | | |  |
| 7.4 Social | Social cohesion  Gender Equity | | | | | Participation in community activities at household level  Management control by gender; market participation by gender. | | | Survey | | | Women solely responsible for household related activities. Low level of farm produce control by women and adult females. | | |  |
|  | | | | | | | | | | | | | | | |
| 8. How will scaling be achieved? | | | | | | | | | | | | | | | |
| * The scaling will be achieved by training a technical team of farmers which will continue after the project * Farmer exchange visits will motivate farmers to adopt the technologies (seeing is believing for farmers) * publication in a peer-reviewed journal | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 9. How are the activities in this protocol linked to those of others? | | | | | | | | | | | | | | | |
| This sub-activity is linked to sub-activity MA1211-21 | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 10. Custom indicators   * Percentage of land area covered by contour bunds * Percentage gains in productivity by applying contour bund technology * Resilience metrics as a result of contour bund interventions * Number of farmers reached by technology | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 11. Impact-based summary matrix | | | | | | | | | | | | | | | |
| 11.1 What is the development challenge you are addressing?  Acceleration of the extension of demonstrations for contour bunding as the demand is high. | | | | | | | | | | | | | | | |
| 11.2 Who is your target audience, e.g., extension agents, farmers, or policymakers?  The target audience are farmers, farmer-based organization, politicians (mayor and counselors of the municipality) | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 12. Budget (US$) | | | | | | | | | | | | | | | |
| Outcome/Output/Activity | | | Sub-activity | | | | | Budget line item | | | | | | IER | |
| Outcome 1/Output 2/  Activity 1 | | | MA1212-21 | | | | | Personnel | | | | | | 16,849 | |
| Services | | | | | | 5,411 | |
| Supplies | | | | | | 3,425 | |
| Capital | | | | | | 0 | |
| Travel | | | | | | 5,462 | |
| Sub-total | | | | | | 31,147 | |
| Overhead (IER 10%) | | | | | | 3,114 | |
| Total IER | | | | | | 34,261 | |
| Overhead (ICRISAT 17%) | | | | | | 5,824 | |
| Total | | | | | | 40,085 | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 13. Gantt Chart | | | | | | | | |
| Year/month | 2021 | | | | | | 2022 | |
| Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb |
| Training farmers on nursery-based agroforestry using fodder trees |  |  |  |  |  |  |  |  |
| Demonstration plot of CB |  |  |  |  |  |  |  |  |
| Continuation of implementation of intercropping sorghum-soybean demonstration plot |  |  |  |  |  |  |  |  |
| Journal article preparation and submission |  |  |  |  |  |  |  |  |
| Data collection |  |  |  |  |  |  |  |  |
| Defense of the thesis |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 1: MA1221-21** | | | | | | | | | | | | | | |
| Outcome 1: Farmers and farming communities in the project area are practicing more productive, resilient, and profitable and sustainably intensified crop-livestock systems linked to markets | | | | | | | | | | | | | | |
| a. Output 1.2 | | | | | Integrated management technologies and practices to improve and sustain productivity and ecosystems services of the soil, land, water and vegetation resources are developed and disseminated to farmers and development partners in the intervention communities | | | | | | | | | |
| b. Activity 1.2.2 | | | | | Test and promote water management technologies and practices to increase water productivity in the small-scale crop-livestock farming systems under rainfed and irrigated conditions | | | | | | | | | |
| c. Sub-activity MA1221-21 | | | | | Evaluate improved irrigation technologies for efficient and sustainable agricultural water management in rural Mali | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | |
| Name | | | | Institution | | Role | | | | | | | | |
| Birhanu Zemadim | | | | ICRISAT | | Activity leader, Land and Water Management Scientist | | | | | | | | |
| Ramadjita Tabo | | | | ICRISAT | | Revising technical reports | | | | | | | | |
| Felix Badolo | | | | ICRISAT | | Economic analysis | | | | | | | | |
| Bougouna Sogoba | | | | AMEDD | | Farmers’ mobilization | | | | | | | | |
| Benedict Boyubie | | | | IITA | | Monitoring and evaluation/data management | | | | | | | | |
|  | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | |
| Name | | | | Institute | | | Degree | | | Start | | | End | |
| Karamoko Sanogo | | | | USTTB | | | PhD | | | Jan. 2017 | | | Mar. 2022 | |
|  | | | | | | | | | | | | | | |
| f. Location(s) | | Koutiala and Bougouni | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| g. Start | | September 2019 | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| h. End | | March 2022 | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | |
| In rainfed agricultural systems, sustainable and efficient water management practices are key to improved agricultural productivity and natural resources management. The agricultural productivity in sub-Saharan Africa (SSA) heavily relies on the availability of rainfall. With the erratic and unreliable rainfall pattern associated with poor and fragile soils, crop and livestock productivity has remained very low over the years in most SSA countries including Mali. Much of the SSA agricultural land has been degraded and became less fertile as a result of continuous years of cultivation and is prone to wind and water erosion. This results in an increased food shortage because the land has not been able to support the food demands of the ever-increasing population. Better agricultural and nutritional security are further hampered by the lack of reliable access to the available water resources in the subsurface.  The two main surface water sources in Mali are the basins of the Senegal River and the Niger River with a total capacity of 70 billion metric cubes of water in an average year. The volume of static underground water reserve is estimated at 2,700 billion metric cubes with an annual recharging rate of 66 billion metric cubes. The surface water contributes about 10 to 15% of the total volume of water consumed by populations, the balance of the demand is covered by underground water (DNH, 2016)[[88]](#footnote-89). Extraction and use of groundwater as a resource have been low mainly because in rural community settings large irrigation systems (through dams) are very expensive to implement (DNH, 2016)[[89]](#footnote-90). Small-scale irrigation systems can be implemented at relatively low costs to benefit smallholder communities.  This work plan aims at improving agricultural productivity, nutritional security, and household incomes through the use of solar energy pumps and improved irrigation technologies for efficient and sustainable agricultural water management in rural Mali. Similar to other SSA countries neither hydrocarbon energized motor pumps nor electrical pumps are affordable by smallholder farmers in rural Mali. Introducing solar energy-based irrigation pumps is ideal for increasing agricultural productivity and diversifying farming practices to produce high valued agricultural products like meat and vegetables. Solar panels are becoming more affordable and the improved solar photovoltaic (PV) technologies, with a low carbon footprint, have been identified as high potential solutions for rural electrification as well as water extraction for domestic, livestock, and irrigation purposes in SSA. As such, solar PV pumps and improved irrigation technologies have become an emerging climate-smart technology in SSA for smallholder farmers (Schmitter *et al.*, 2018)[[90]](#footnote-91). To be highly productive solar irrigation technologies need to be accompanied by improved agronomic management practices and soil moisture conservation techniques. Most of the data have been collected from 2019 to 2020 and analyzed. A technical report titled ‘Irrigation technologies for efficient and sustainable agricultural water management in rural Mali focusing on land and soil characterization of potential agricultural investment zones in Bougouni and Koutiala’ has been produced and uploaded on CGSPACE. <https://hdl.handle.net/10568/113774>. From the data collected in 2019, a second technical report titled ‘Improved irrigation technologies for efficient and sustainable agricultural water management in rural Mali: Results Based on the Sustainable Intensification Assessment Framework’ has been produced and uploaded on CGSPACE. <https://hdl.handle.net/10568/113759>. The activity for 2021/2022 will be to work on the identification of public-private partnerships through multi-stakeholder approaches to avail and promote solar energy pumps and improved irrigation technologies to smallholder farmers. During the review and planning meeting conducted on May 26 & 27, 2021 the meeting participants highlighted an existing experience on public-private partnerships for low-cost solar pumps in Ghana for irrigation practices. IWMI Ghana office has developed a partnership model with low-cost irrigation technology suppliers in Ghana and we will jointly study and adopt IWMI’s approach for Mali. Additionally, a manuscript will be submitted as a task for this reporting year. All data collected from 2019 to 2021 will be used to prepare the manuscript along with biophysical data sets collected in the Africa RISING project since 2014. | | | | | | | | | | | | | | |
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| 2. Objectives | | | | | | | | | | | | | | |
| 2.1 Evaluate existing initiatives and constraints in using efficient and sustainable water management practices using solar energy pumps and improved irrigation technologies | | | | | | | | | | | | | | |
| 2.2 Identify public-private partnership through multi-stakeholder approaches to avail and promote solar energy pumps and improved irrigation technologies to smallholder farmers | | | | | | | | | | | | | | |
| 2.3 Conduct a multi-criteria GIS framework assessment to map potential agricultural water management investment areas based on climate, topography, and aquifer characteristics | | | | | | | | | | | | | | |
| 2.4 Develop appropriate and affordable methodology in using solar irrigation technologies along with improved agronomic management and soil moisture conservation technologies | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | |
| 3.1 What are the existing initiatives and constraints of solar energy pumps and improved irrigation practices in Africa RISING intervention communities? | | | | | | | | | | | | | | |
| 3.2 Who are the reliable public-private partners to lead the development and dissemination of solar energy pumps and improved irrigation practices in the intervention communities? | | | | | | | | | | | | | | |
| 3.3 What are the solutions for potential agricultural water management investment for smallholder rural communities? | | | | | | | | | | | | | | |
| 3.4 What synergies exist among different actors that practice sustainable water resources management, improved agronomic, and soil conservation technologies? | | | | | | | | | | | | | | |
| 3.5 How do we scale and promote the proven agronomic, water management, and soil and water conservation practices? | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | |
| The work utilized survey data information on existing initiatives and practices of utilizing solar energy-based pumps and improved irrigation practices in Koutiala and Bougouni. This activity was completed and a technical report has been produced and uploaded on CGSPACE.  Sanogo, K. and Zemadim, B. 2021. Improved irrigation technologies for efficient and sustainable agricultural water management in rural Mali: Results Based on the Sustainable Intensification Assessment Framework. Ibadan, Nigeria: IITA. <https://hdl.handle.net/10568/113759>.  The design of solutions for agricultural water management investment options for the smallholder farming communities is under preparation to be included in the manuscript. GIS and Remote Sensing technologies along with climate information (e.g., solar radiation, number of sunshine hours, etc.) are being used to characterize and define suitable zones to implement solar-based energy pumps. Efficient water management solutions will be accompanied by other technologies (improved crop cultivars, soil and water conservation practices, and agronomic packages) to evaluate the gains in productivity, environmental, economic, social, and human well-being of the sustainability options. | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | | | Responsibility/Institution | | |
| Is the collected data part of a multi-year experiment? Yes | | | | | | | | | | | |  | | |
| 5.1 Land and soil characterization data ground-truthed in 2020 | | | | | | | | | | | | Karamoko Sanogo/ICRISAT | | |
| 5.2 Suitability maps on potential agricultural investment zones in different agro-ecologies (2020/2021) | | | | | | | | | | | | Birhanu Zemadim and Karamoko Sanogo/ICRISAT | | |
|  | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | |
| Deliverables | | | | | | | | Means of verification | | | | | | Delivery date |
| 6.1 Report on land and soil characterization of potential agricultural investment zones | | | | | | | | Report uploaded on CGSPACE | | | | | | Delivered  <https://hdl.handle.net/10568/113774>. |
| 6.2 Multi-criterial decision making (MCDM) tool developed as a planning and management solution to assess the potential of agricultural water management investments | | | | | | | | Confirmation by journal on submission of article | | | | | | Mar. 2022 |
| 6.3 Finalization of the West Africa Handbook chapter in collaboration with the co-authors as a team | | | | | | | | Handbook revisions | | | | | | Dec. 2021 |
|  | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators and metrics | | | | | | | | | | | | | | |
| Domain | Indicator | | Metrics/Scale | | | Approach used | | | Before intervention | | After intervention | | | |
| 7.1 Productivity | Crop Productivity | | Grain yield and biomass (kg/ha/season) at plot level.  Farmer perceptions and ratings of technology yield performance as a result of the technologies at household level. | | | Survey | | | Yield of onion was 7,500 kg/ha/season.  Yield of tomato was 14,500 kg/ha/season.  Stover yield of tomato was 900 kg/ha/season. | | Yield of onion was 12,500 kg/ha/season  Yield of tomato was 25,000 kg/ha/season  Stover yield of tomato was 1,600 kg/ha/season.  Onion (49%) and tomato (27%) were the two most widely practiced vegetable production by farmers during the dry season. | | | |
| 7.2 Environmental | Soil moisture  Ground water level | | Number of days during growing season without adequate soil moisture (from rain or irrigation) for crop growth at farm level.  Farm-level: Depth to shallow groundwater  Household: Number of months without adequate supply of clean drinking water (within 500 m) and farmer perceptions of water availability.  Landscape level: Percentage households with year-round access to drinking water. Percentage of livestock farmers with year-round access to water. Percentage of irrigable land (given current investment) with sufficient irrigation water. Percentage of streamflow not diverted for agriculture or drinking water. Percentage of water sources (wells, streams) with clean water.  Percentage of population with year-round clean drinking water. | | | Survey | | | No data | | Number of days during growing season with and without adequate soil moisture was estimated using irrigation interval. Irrigation interval for onion and tomato varied from 12 to 72 hours, with a mean of 14.41 hours. The soil’s ability to store water for all vegetables varied from 1 to 5 days, with an average of almost 2 days.  The percentage of irrigated land was estimated and results revealed that 67% of land under irrigation had sufficient water. The source of water from aquifers ranged from 2 to 94 m depth with an average of 19 m.  Analysis of farmers’ perception of water availability revealed that about 39% are without adequate supply of water, whereas 61% observed shortages very often. All respondents recognized that there is a shortage of water year-round.  Water from solar-powered irrigation pumps was always available for household consumption (60%), livestock (28%) and irrigation (15 %). The minimum quantity of water supplied for irrigation was 10 l/day. The maximum supplied varied according to the importance given to the vegetable by a farmer. Onion is the highest consumer of water (1200 l/day) with a mean value of 369 l/ day.  Irrigation of vegetables was done at the end of the rainy season with a solar-powered irrigation pump. Sixty-nine percent of respondents provided irrigation once in the dry season, and 24% conducted irrigation twice (rainy and dry season). Supplementary irrigation during the rainy season was mostly for okra and pepper. Despite the lack of water in the dry season, 7% of farmers practiced irrigation twice. | | | |
| 7.3 Economic | Profitability | | Net returns per unit labor input, land input, capital input, at plot level.  Percentage of production sold (by crop, animal product).  Percentage of land allocated to cash crops at farm level. Percentage of total income from agriculture.  Percentage of total consumption from own production at household level. | | | Survey | | |  | | Economic analysis is underway. Preliminary results revealed that more than 50% of most vegetables produced were for sale. While pepper, African eggplant, tomato, and okra are for sale most of the time, the production of lettuce was for household consumption with 59% rate of consumption, followed by onion (53%), and amaranth (51%).  Farmers can get up to 40,265 FCFA per season selling pepper followed by onion (36,457 FCFA). The low-income vegetables were amaranth and lettuce with 6,000 FCFA and 13,919 FCFA, respectively.  Most of the time amaranth, lettuce and African eggplant are cultivated for household consumption. These vegetables are available for sale when production is higher than household need. Producers benefit by up to 5 million FCFA from the irrigation in one season.  Ownership of irrigated land allocated for cash crops showed that 43% of the land belonged to the head of the household, and 33% to the village chief. Project-initiated irrigation systems were invariably constructed on the property of the village chief so that not everyone has access to it. Nearly 6.25% of the farmers borrow land for vegetable production. | | | |
| 7.4 Social | Equity  Level of social cohesion | | Variability and distribution of productivity, income and assets at the landscape level.  Active farmer groups, active innovation platforms, percentage of community members participating in some form of social group, number of conflicts over resources.  Formal agreements for resource sharing at the landscape level. | | | Survey | | |  | | Solar pumped irrigation systems contributed to more than 40% of the income in 31% of the population in the project communities. In 18% of respondent incomes, solar irrigation contributed up to 30%. Additionally, 14% and 15% of respondents in Bougouni and Koutiala districts indicated that solar irrigation increased their incomes by 20% and 10%, respectively. For 21% of the respondents, agricultural income increased by 5%. | | | |
| 7.5 Human | Nutrition | | Market supply of diverse food.  Infrastructure (e.g., warehousing, access to markets/roads, irrigation; dependent on geography). Number of farmers experimenting with the technology at the landscape level. | | | Survey | | |  | | Supply of vegetables using solar energy pumps increased by 30%. A total of 110 farmers are implementing the irrigation technology in the intervention villages. In the intervention villages, 64% of female farmers are involved in the irrigation system, while 36% are male farmers. | | | |
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| 8. How will scaling be achieved? | | | |
| Scaling is achieved through field demonstration of technologies perceived as important by farmers. During phase I of the project, we already established three solar pumped drip irrigation systems in the three technology parks. Farmers will be invited to witness the use of a combination of agronomic, soil, and water conservation and improved irrigation technologies. The three sites will be demonstration places for research and capacity-building activities. NGOs (AMEDD and FENABE) and farmers’ organizations will be beneficiaries of the technologies. Scaling out of the practices will be done through government extension systems, local and international NGOs, and other donors who are willing to invest in the practices for the smallholder farmers. | | | |
|  | | | |
| 9. How are the activities in this protocol linked to those of others? | | | |
| This activity is linked to subactivities MA1211-21 and MA1212-21 | | | |
|  | | | |
| 10. Custom indicators | | | |
| * Number of beneficiaries of solar-based water pumps * Amount and types of crops grown with solar-based water pumps * Type of business enterprises promoting solar-based water pumps | | | |
|  | | | |
| 11. Impact-based summary matrix | | | |
| 11.1 What is the development challenge you are addressing?  In rural Mali, agricultural production and productivity have been hampered by a lack of reliable rainfall. In most cases, the number of dry spells exceeds two to three weeks and frequent occurrence of terminal droughts are hampering gains in productivity usually during grain filling periods. The presence of improved water management practices, like that of solar-powered irrigation systems, is ideal to avail the required water input for supplementary irrigation during the rainy season and production of high valued crops during the dry season. | | | |
| 11.2 Who is your target audience, e.g. extension agents, farmers, or policymakers?  Farmers in rural communities are the target groups. Also, suppliers of low-cost solar pumps and enterprises working on infrastructure development are targeted. | | | |
|  | | | |
| 12. Budget (US$) | | | |
| Outcome/Output/Activity | Sub-activity | Budget line | ICRISAT |
| Outcome 1/Output 2/Activity 2 | MA1221-21 | Personnel | 29,000 |
| Services | 6,500 |
| Supplies | 3,500 |
| Capital | 0 |
| Travel | 4,500 |
| Sub-total | 43,500 |
| Overhead (17%) | 7,395 |
| Total | | | 50,895 |

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| 13. Gantt Chart | | | | | | | | | |
| Year/month | 2021 | | | | | | 2022 | | |
| Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar |
| Data analysis and formatting |  |  |  |  |  |  |  |  |  |
| Field data collection and analysis |  |  |  |  |  |  |  |  |  |
| Continue towards development of the West Africa Handbook |  |  |  |  |  |  |  |  |  |
| Scientific article writing and submission |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 2: MA2221-21** | | | | | | | | | | | | | | | |
| Outcome 2: More farmers and farm families in the intervention communities are adopting technologies and practices to improve nutrition, food and feed safety, post-harvest handling and value addition | | | | | | | | | | | | | | | |
| a. Output 2.2 | | | | | Postharvest technologies and practices to provide options for the food and feed sectors are tested and disseminated to farmers through researchers, extension staff, and development partners | | | | | | | | | | |
| b. Activity 2.2.2 | | | | | Build capacity of farm families to reduce postharvest losses | | | | | | | | | | |
| c. Sub-activity MA2221-21 | | | | | Training of farmers on postharvest and processing technologies | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | | |
| Name | | | Institution | | | | | Role | | | | | | | |
| Wubetu Legesse | | | Worldveg | | | | | Activity leader | | | | | | | |
| Mahamadou Dicko | | | AMEDD | | | | | Community mobilization | | | | | | | |
| Edoh Kokum | | | WorldVeg | | | | | Organization of farmers’ trainings | | | | | | | |
| Benedict Boyubie | | | IITA | | | | | Monitoring and evaluation/data management | | | | | | | |
|  | | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | | |
| Name | | | Institute | | | | | | Degree | | | Start | | End | |
| N/A | | |  | | | | | |  | | |  | |  | |
|  | | | | | | | | | | | | | | | |
| f. Location(s) | | Bougouni and Koutiala districts | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| g. Start | | September 2020 | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| h. End | | June 2022 | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | | |
| The research on the ZECC technology showed that ZECC is effective in reducing the ambient temperature by 10 OC to 15OC, which extends tomato and leafy vegetable’s shelf life for two weeks. This sub-activity concerns providing capacity building to participating farmers on postharvest and processing technologies to ease their adoption. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | | |
| 2.1 Disseminate knowledge and equipment on best postharvest management practices that reduce product losses during storage through training by imparting knowledge, skills, and practices. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | | |
| 3.1 Can training and practice enable farmers to reduce postharvest losses during storage? | | | | | | | | | | | | | | | |
| 3.2 To which extent do farmers apply the gained knowledge and skills in vegetable production? | | | | | | | | | | | | | | | |
| 3.3 What are farmers’ reasons for preference for certain postharvest storage and processing technologies? | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | | |
| The training sessions on postharvest technologies will be conducted at Africa RISING technologies parks (Bougouni and Koutiala). The training topics will cover practical and theoretical sessions on (i) the causes of vegetable product losses, (ii) how to build zero-energy cooling chambers, (iii) management of ZECC, and (iv) diverse processing techniques. Two sessions are planned in each district (Bougouni & Koutiala) during the dry season. Data will be collected on the number of participants segregated into sex and age, farmers’ preferences for treatments, and the reasons for choosing an option. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded in Dataverse | | | | | | | | | | | | Responsibility/Institution | | | |
| Is the data collected part of a multi-year experiment? Yes | | | | | | | | | | | |  | | | |
| 5.1 Number of participants receiving training, sex and age disaggregated | | | | | | | | | | | | WorldVeg | | | |
| 5.2 Data on farmers’ preferences for postharvest treatments and the reasons for choosing an option | | | | | | | | | | | | WorldVeg | | | |
|  | | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | | | Delivery date | |
| 6.1 Report on the training sessions | | | | | | | Summary report included in technical report to IITA | | | | | | | Mar. 2022 | |
| 6.2 Report on farmers’ preferences with respect to postharvest technologies | | | | | | | Report uploaded on CGSpace | | | | | | | May 2022 | |
| 6.3 Article on the effect of manure application on tomato qualities | | | | | | | Confirmation from journal about manuscript submitted | | | | | | | May 2022 | |
| 6.4. Contribution to the WA handbook of technologies finalized | | | | | | | Book chapter completed | | | | | | | December 2021 | |
|  | | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators and metrics | | | | | | | | | | | | | | | |
| Domain | Indicator | | | | | Metrics/Scale | | | | Approach used | Before intervention | | | | After intervention |
| 7.4 Social | Equity,  Collective action | | | | | Rating of technologies by group at household level,  Participation in collective action group at household level | | | | Group interview in each district | Less than 5% access to seeds & inputs for women.  Less than 10 % women were trained in vegetable good management practices.  Youth are connected & have more access to irrigated vegetable technologies | | | |  |
|  | | | | | | | | | | | | | | | |
| 8. How will scaling be achieved? | | | | | | | | | | | | | | | |
| The training approach is the cascade training or training of trainers provided to extension agents, NGOs, vegetable retailers and food processors. It is expected that partners attending the training sessions such as NGOs (AMEDD, EDUCO, WFP, GIZ, etc.) will ease knowledge transfer to more beneficiaries beyond the project intervention zones. In May 2020, EDUCO, an NGO, dedicated to children nutrition and education visited AR activities and farmers in Koutiala and wants to replicate the approach in Segou region. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 9. How are the activities in this protocol linked to those of others? | | | | | | | | | | | | | | | |
| This sub-activity is related to sub-activity MA1114-21. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 10. Custom indicators | | | | | | | | | | | | | | | |
| * Number of Training sessions * Number of farmers reached concerning postharvest technologies | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 11. Impact-based summary matrix | | | | | | | | | | | | | | | |
| 11.1 What is the development challenge you are addressing?  Postharvest losses of vegetables were ranked among the top constraints of vegetable production in Mali. Deficiencies of knowledge on adapted and affordable postharvest technologies are the major challenges faced by vegetable growers in Bougouni and Koutiala. It is expected that the project beneficiaries’ capacity to implement postharvest technologies will improve because they will have a better understanding of the procedures that lead to optimized uses of the technologies and extend the products’ shelf life for more consumption and income thus addressing malnutrition and poverty. | | | | | | | | | | | | | | | |
| 11.2 Who is your target audience, e.g., extension agents, farmers, or policymakers?  The beneficiaries are farmers in the intervention sites, food processing associations, vegetable retailers, extension agents, and policymakers. | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | |
| 12. Budget (US$) | | | | | | | | | | | | | | | |
| Outcome/Output/Activity | | | | Sub-activity | | | | | | Budget line | | | WorldVeg | | |
| Outcome 2/Output 2/  Activity 2 | | | | MA2221-21 | | | | | | Personnel | | | 3,000 | | |
| Services | | | 4,000 | | |
| Supplies | | | 1,000 | | |
| Capital | | | 0 | | |
| Travel | | | 2000 | | |
| Sub-total | | | 10,000 | | |
| Overhead (18.2%) | | | 1,820 | | |
| Total | | | 11,820 | | |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 13. Gantt Chart | | | | | | | | | | |
| Year/Month | 2021 | | | | 2022 | | | | | |
| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul |
| Organization of farmers for capacity building |  |  |  |  |  |  |  |  |  |  |
| Organization of four farmers’ field days |  |  |  |  |  |  |  |  |  |  |
| Participatory selection of post-harvest storage options and processing technologies |  |  |  |  |  |  |  |  |  |  |
| 2 Reports preparation and submission |  |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol –Outcome 3: MA3112-21** | | | | | | | | | |
| Outcome 3: Farmers and other value chain actors have greater and equitable access to production assets and markets (input and output) through enabling institutions and policies | | | | | | | | | |
| a. Output 3.1 | | Enabling policies and institutional arrangements to increase participation of farm families, especially women and youth in the output and input markets and decision-making are advocated for implementation by national governments, policy makers and development partners | | | | | | | |
| b. Activity 3.1.1 | | Review of existing policies and institutional arrangements affecting equitable access to production assets and markets | | | | | | | |
| c. Sub-activity MA3112-21 | | Analyze the enabling environment including policies and institutional arrangements and intervention to identify factors that enable the inclusion of women and youth along irrigated vegetable value chain in Mali | | | | | | | |
| d. Research team | | | | | | | | | |
| Name | | Institution | | Role | | | | | |
| Thai Minh | | IWMI | | The Senior researcher: responsible for the systemic analysis of the scaling pathway for irrigated vegetable value chain in Ghana and Mali. She will carry out data collection and analysis on SI indicators mainly on social and human condition to evaluate holistic sustainability of the interventions | | | | | |
| National Researcher Scaling Innovations (TBD) | | IWMI | | The National Researcher will support the data collection on the systemic analysis component. | | | | | |
| Jean Baptiste Tignegre | | World Veg | | Contribution on vegetable value chain | | | | | |
| Benedict Boyubie | | IITA | | Support towards meeting project M&E requirements and FtF indicators while ensuring data upload on Datasevers | | | | | |
| Birhanu Zemadim | | ICRISAT-Mali | | Contribution on sub-activity conducted in Mali | | | | | |
|  | | | | | | | | | |
| e. Student(s) | | | | | | | | | |
| Name | | Institute | | | Degree | | Start | End | |
|  | |  | | |  | |  |  | |
| f. Location(s) | Mali | | | | | | | | |
|  |  | | | | | | | | |
| g. Start | September 2020 | | | | | | | | |
|  |  | | | | | | | | |
| h. End | March 2022 | | | | | | | | |
|  |  | | | | | | | | |
| 1. Justification | | | | | | | | | |
| In addition to the Bhungroo solar-based irrigation system and drip irrigation, several other pieces of research showed promise of using different water-lifting technologies and irrigation management to support off-season vegetable, seed, and irrigated fodder production (Okwany and Schmitter, 2016[[91]](#footnote-92), Schmitter et al., 2016[[92]](#footnote-93)). Moreover, research has identified numerous constraints to expanding the use of irrigation technologies along the value chains. The heterogeneity of farmers and respective demographics influences the preferences for technologies and therefore the level of entrepreneurship. Barriers, which prevent smallholder farmers in Ghana and Mali from entering into or advancing along the value chains are highly contextual and vary within and between countries; some key identified challenges are: (i) insecurity of land tenure; (ii) lack of infrastructure (e.g. roads, access to electricity, well drilling); (iii) limited access to irrigation technologies and/or credit; (iv) lack of after-sale services (e.g. maintenance, spare parts); (v) lack of reliable markets (both in terms of the crop value chains and the technology supply chains), (vi) inadequate or poorly maintained irrigation infrastructure and (vii) changing demographics of people in agriculture (women and shortage of labor) (Nakawuka et al., 2018[[93]](#footnote-94); Merry and Lefore, 2018[[94]](#footnote-95); Lefore et al., 2019[[95]](#footnote-96)).  A systemic approach to the scaling of irrigation technology and water management solutions to enhance value chain functionality is needed through addressing these systemic barriers. The systemic scaling approach helps to explore sustainable pathways to scaling so that irrigation technologies can better support sustainable intensification of household production systems, development of agricultural value chains, and resilience of food systems. To support systemic scaling of irrigation solutions for sustainable intensification, it is essential to conduct an enabling environment assessment to understand enablers and hinderers influencing farmers’ adoption of the technologies, so that measures are put in place to ensure success. Currently, IWMI is implementing several related initiatives on systemic scaling of small-scale irrigation (SSI) in Mali. Systemic scaling includes (1) water suitability/accounting, (2) enabling environment assessment, (3) co-identification of value chain scaling pathway, and (4) multi-stakeholder dialogues. These types of research have been conducted under the scope of Africa Rising (Ethiopia), TAAT and ILSSI projects.  In Mali, under the scope of the TAAT project, the enabling environment assessment is being conducted to understand enablers and hinderers influencing farmers’ adoption of the irrigation technologies, so that measures are put in place to ensure successful scaling of irrigation; while the ILSSI project works on water suitability and accounting. However, for scaling pathways to be gender and socially inclusive it is important to understand who participates and who benefits. This requires a contextualization of the scaling framework which captures not only the agricultural value chains but also the micro and macro environments of households, decision-making powers, and understanding entry points for women and youth along irrigated agricultural value chains at a local level. IWMI, therefore, proposes to develop contextually relevant inclusive scaling pathways by addressing the barriers for women and youth to partake in irrigated agricultural value chains.  The scaling pathways through an enabling environment lens for irrigated agricultural value chains is a set of policies, informal institutions, support services, and other conditions that create or improve gender and social inclusion and maintain a general operational environment, bringing together value chain actors in a cooperative manner. Understanding such micro and macro environments of households and value chains as well as its influence on the scaling of irrigation technologies is important when catalyzing the appropriate enabling environment for integration and scaling of the irrigation technology and water solutions in sustainable manners (Lefore et al., 2019). | | | | | | | | | |
|  | | | | | | | | | |
| 2. Objectives | | | | | | | | | |
| 2.1. Identify factors that enable the inclusion of women and youth along the irrigated vegetable value chain, especially in the output and input markets for irrigated vegetable production | | | | | | | | | |
|  | | | | | | | | | |
| 3. Research questions | | | | | | | | | |
| 3.1. What characterizes the enabling environment that facilitates the participation of farm families, and enables the inclusion of women and youth along irrigated vegetable value chains? | | | | | | | | | |
|  | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | |
| The sub-activity is embedded in the action research outlined under the proposed systemic scaling pathway analysis in outcome 3.2 (MA3211-21).  The policy framework and intervention analysis will involve a review of policy clusters that influence the scaling of irrigation technologies and irrigated vegetable value chain development. The analysis will proceed in six steps, namely: (i) development of an inventory of relevant and existing policy/intervention documents, (ii) individual policy/intervention analysis, (iii) policy/intervention cluster analysis, (iv) cross-cluster analysis, (iv) overall analysis, and (v) validation of results.  The results from the policy framework and invention analysis will be consolidated through a synthesis analysis. The synthesis analysis will first characterize the enabling environment for scaling irrigation technologies and irrigated vegetable value chain development by reflecting on the results from analyses of policies and interventions, and draw inferences on:   * achievements and shortcomings in the technology scaling and irrigated vegetable value chain development * alternative scenarios/solutions/models/approaches that could have addressed the shortcomings/constraints better * produce specific policy and implementation recommendations | | | | | | | | | |
|  | | | | | | |  | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | Responsibility | | |
| Policy frameworkwith different policy clusters including socio-economic development framework, rural and agricultural development, social and gender inclusion, irrigation and water resources management, vegetable production, private sector development, etc. Objectives, target areas, and beneficiaries, implementation strategies and mechanisms, institutional arrangements, changes in policy framework, conflicts, gaps, shortcomings. | | | | | | | Minh Thai/IWMI | | |
| Enabling and disenabling factors to farmers’ participation in irrigated vegetable value chain, drivers, and potentials solutions/recommendations | | | | | | | Minh Thai/IWMI | | |
| Interventionsthat support farmers’ participation and enable the inclusion of women and youth along irrigated vegetable value chains | | | | | | | Minh Thai/IWMI | | |
|  | | | | | | | | | |
| 6. Milestones | | | | | | | | | |
| Deliverables | | | | Means of verification | | | Delivery date | | |
| 6.1 Database and qualitative dataset on enabling environment facilitating the scaling of irrigation and water solutions | | | | Dataverse | | | Jun. 2021 | | |
| 6.2 Report on enabling factors facilitating the inclusion of women and youth along irrigated vegetable value chain, especially in the output and input markets for irrigated vegetable production in Mali | | | | Progress and final report submitted to IITA | | | Dec. 2021 | | |
| 6.3 WA technology handbook | | | | Finalize contribution for the WA handbook | | | Dec. 2021 | | |
|  | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | |
| Domain | Indicator | | Metrics/  Scale | Approach used | | Before intervention | | | After intervention |
| 7.1 Productivity |  | |  |  | |  | | |  |
| 7.2 Environmental |  | |  |  | |  | | |  |
| 7.3 Economic |  | |  |  | |  | | |  |
| 7.4 Social | Collective action | | Participation in a collective action group or a social group  Capacity of group | Key Informant Interviews;  Focus group discussion | |  | | |  |
| 7.5 Human |  | |  |  | |  | | |  |

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| 8. How will scaling be achieved? |
| Scaling will be achieved by series of stakeholder engagement and system scaling activities, including, but not limited to:   * Using co-generation of knowledge through on-farm demonstration to scale out innovative technologies; * Organizing stakeholder meetings with farmers and extension officers on the results of the trials and the preferred water lifting and application methods during the dry season; * Sharing research results and engaging with potential scaling partners such as regional offices of the Ministry of Food & Agriculture and other relevant government organizations * Linking AR’s irrigation technology and value chain-based scaling pilots with relevant multi-stakeholder dialogues/platforms to integrate the scaling into the platforms’ agendas and to facilitate the systemic changes and capacity to enhance the scaling of irrigation technologies and water solutions * Developing and using fact sheets, workshops, policy briefs, as well as scientific papers to communicate to the wider public actors, practitioners, and relevant stakeholders. |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| This sub-activity experiment is linked to scaling research conducted by IWMI for small-scale irrigation technology to support farmer-led irrigation expansion. In addition, it is linked to sub-activities planned by the World Vegetable Centre under MA1115-21 and MA1116-21. And by STEPRI on policy and institutional analysis. |
|  |
| 10. Custom indicators |
| * Number of demonstrations established * Number of farmers trained * Number of field days organized * Number of meetings/workshops attended * Number of project reports produced * 1 journal article submitted/published |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  This sub-activity will address the following major development challenges:   * highly vulnerable to the effects of climate change, while farmers are cultivating in marginal lands with low and erratic and are exposed to more frequent and longer dry spells and floods that threaten food security. * Social and gender norms hindering social inclusion, together with limitation in the physical environment obstruct the investment and expansion of irrigation. * Along the agricultural value chain, constraints to smallholders’ access to water management technologies and equipment as well as investment to irrigation include under-developed irrigation value chains and capacities, under-developed irrigation supply chain, limited access to finance, energy, knowledge services to invest in irrigation, and weak input and output market linkages; * Government policies and programs are biased towards large-scale irrigation and production system and lag behind efforts of smallholder farmers and the private sector in AWM;   11.2 Who is your target audience, e.g. extension agents, farmers, or policymakers?  The most important audience includes small-scale farmers, women, and youth involved in farming, extension and development agents, policymakers, and the private sector who are working on irrigation and solar-powered products. |

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| 12. Budget (US$) | |
| Budget Line | IWMI |
| Personnel |  |
| Services | 8,067 |
| Supplies | 0 |
| Capital | 0 |
| Travel |  |
| Overhead (19%) | 1,533 |
| Total | 9,599 |

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| 13. Gantt Chart | | | | | | | | | | |
| Year/month | 2021 | | | | | | | 2022 | | |
| Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar |
| Policy framework analysis |  |  |  |  |  |  |  |  |  |  |
| Irrigation and irrigated value chain intervention analysis |  |  |  |  |  |  |  |  |  |  |
| Reflection, data analysis and report writing |  |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 3: MA3121-21** | | | | | | | | | | | | | |
| Outcome 3: Farmers and other value chain actors have greater and equitable access to production assets and markets (input and output) through enabling institutions and policies | | | | | | | | | | | | | |
| a. Output 3.1 | | Enabling policies and institutional arrangements to increase participation of farm families, especially women and youth in the output and input markets and decision-making are advocated for implementation by national governments, policymakers and development partners | | | | | | | | | | | |
| b. Activity 3.1.2 | | Assess the level of inclusiveness of women and the youth along the crop and livestock value chains | | | | | | | | | | | |
| c. Sub-activity MA3121-21 | | Assessing the inclusiveness of women and youth within the vegetable production value chain to enhance vegetable production among smallholder farmers | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | |
| Name | | Institution | | | | Role | | | | | | | |
| Jean Baptiste Tignegre | | WorldVeg | | | | Sub-activity leader and activity coordination | | | | | | | |
| Fred Kizito | | IITA | | | | Scientific advice to Worldveg team | | | | | | | |
| Funke Cofie | | IWMI | | | | Providing scientific support to collect information that support higher level analysis | | | | | | | |
| Felix Badolo | | ICRISAT | | | | Supervising fieldwork and data collection | | | | | | | |
| Benoit Gohevi | | UDS | | | | Leading the development and implementation of survey protocol | | | | | | | |
| Benedict Ebito Boyubie | | IITA | | | | Developing data collection tools, training the research team on Feed the Future indicators, and supporting data collection to track output level and Feed the future indicators,  Ensuring data upload on DataVerse | | | | | | | |
| District Director of Agriculture | | DNA, Department of Agriculture | | | | Helping link the various actors and increasing their access to technologies and information | | | | | | | |
|  | |  | | | |  | | | | | | | |
| Student (s) | | | | | | | | | | | | | |
| Name | | Institute | | | | | | | |  | |  |  |
| NIL | |  | | | | | | | |  | |  |  |
|  | |  | | | | | | | |  | |  |  |
| e. Location(s) | | Bougouni and Koutiala districts | | | | | | | | | | | |
|  | |  | | | | | | | | | | | |
| f. Start | | October 2021 | | | | | | | | | | | |
|  | |  | | | | | | | | | | | |
| g. End | | September 2022 | | | | | | | | | | | |
|  | |  | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | |
| The vegetable value chain is plagued with several challenges in Mali. Like Ghana, these challenges are low prices, price volatility, lack of access to credit, poor quality of produce, inadequate storage and warehousing facilities, inadequate transportation facilities, scattered sources of supply, high credit interest rates, and lack of adequate information. Trials with different vegetable varieties were conducted since 2012 in southern Mali including variety dissemination and optimized maize-vegetables intercrops. New WorldVeg commercialized onion, tomato, and pepper varieties proved to be high-yielding with market opportunities for small-scale farmers. IWMI has developed water-management technologies for water use efficiency to sustain vegetable production. However, low access to seeds (seed regulation issues for new promising lines, unavailability of seed enterprises and dealers in the vicinity of farmers’ communities, low capacity of seed and inputs actors, poor linkages of market and processing industries) proved to be threats to the vegetable value chains. These challenges affect vulnerable persons such as women and youth productivity to varying degrees. Vegetable value chain strengthening can be an effective instrument with which to fight inequality by expanding women’s and youth’s incomes and achieving a more balanced value-added appropriation. The involvement of women and youth in the value chain of high-value crops such as irrigated vegetables can sustain production and reduce poverty for poor households. There is, therefore, the need to include women and youth in southern Mali as key players within the value chain (DNA, ICRISAT, IWMI, WorldVeg, banks, input dealers, private sector, commodity aggregators, end markets, and media) to establish long-term relationships and transform small-scale vegetable production into sustainable businesses. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | |
| 2.1 Identify key constraints within vegetable value chains to sustain food security mechanisms for women and youth at community level. | | | | | | | | | | | | | |
| 2.2 Involve women and youth within the vegetable value chains (production, irrigation, input supply, processing, and market). | | | | | | | | | | | | | |
| 2.3 Facilitate the active involvement of women and youth in the irrigated vegetable value chains. | | | | | | | | | | | | | |
| 2.4 Create sustainable linkages between women and young vegetable farmers in the value chain based on innovative approaches such as seed and inputs dealers/enterprises with communities and strengthen existing ones. | | | | | | | | | | | | | |
| 2.5 Initiate local partnership between seed regulators and seed cooperatives/enterprises to register and produce seeds of farmers’ preferred varieties derived from the Africa RISING project. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 3. Research questions/hypotheses | | | | | | | | | | | | | |
| 3.1 What are the key constraints within the vegetable seeds and inputs value chain? | | | | | | | | | | | | | |
| 3.2 Who are the key actors within the vegetable seeds and inputs value chain? | | | | | | | | | | | | | |
| 3.3 Can women and youth be encouraged as seed producers (out-growers for seed enterprises) to participate actively in the seeds and inputs value chain? | | | | | | | | | | | | | |
| 3.4 How will the linkages between smallholder vegetable farmers and key seed and other inputs value chain actors be created or strengthened and how will sustainable linkages be created? | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | |
| A baseline survey will be conducted in the intervention districts to identify key actors (existing or new) within the vegetable seeds and inputs value chain and their level of functionality. Community forums will be organized at the community level to create a platform for smallholder vegetable farmers and key actors in the vegetable value chain for dialogue and identification of various constraints. | | | | | | | | | | | | | |
|  | | | | | | | | | |  | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | Responsibility/Institution | | | |
| Are the collected data part of a multi-year experiment/trial? Yes | | | | | | | | | |  | | | |
| 5.1 Survey data on various key actors and constraints in the vegetable value chain | | | | | | | | | | Jean-Baptiste Tignegre /WorldVeg | | | |
|  | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | Delivery date | | |
| Reports on linkages created (contracts formalized) | | | | | | | Project report showing number of contracts and quantity of seed delivered (i) by seed enterprises and agro-dealers to beneficiaries, (ii) by female and young outgrowers to seed enterprises (iii) under supervision or involvement of ARI, MoFA (DoA) & NGOs | | | | Oct. 2021 | | |
| Baseline survey data | | | | | | | Data uploaded on DataVerse | | | | Dec. 2021 | | |
| Report on community forums organized | | | | | | | Summary report included in the Africa RISING technical report | | | | Feb. 2022 | | |
| A brochure on seed production, water and fertilizer management | | | | | | | A brochure uploaded on CGSPACE | | | | Feb. 2022 | | |
| Report on women and youth involved in seed and inputs value chain through seed production of key vegetable species | | | | | | | Summary report included in the Africa RISING technical report | | | | May 2022 | | |
| A report on knowledge and information sharing forum | | | | | | | Summary report included in the Africa RISING technical report | | | | Jun. 2022 | | |
|  | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | |
| Domain | Indicator | | Metrics/Scale | | Approach  used | | | Before intervention | | | After intervention | | |
| 7.1 Production | Crop Productivity,  Input use efficiency | | Seed yield (kg/ha) at which scale?  Seed yield (kg/m3 water used), at which scale?  Seed yield (kg/kg fertilizer used) at which scale? | | Record data on seed amount, area covered, water and fertilizers | | | Available amount of seed/crop (baseline) | | | Available quantity of seed/crops (endline) | | |
| 7.3 Economic | Market participation,  Market orientation | | % Production sold,  % Land under cash crops  at household level | | Group discussions ; Forums | | | % Production sold and % land covered with cash crops at household before intervention | | | % Production sold and % land covered with cash crops at household level after intervention | | |
| 7.4 Social | Gender equity | | Equal Access to information and knowledge within seed and other inputs value chain at household level | | Group discussions, Forums | | | Limited access to seed & other inputs value chain information- No seed and other inputs order previously planned | | | A platform of actors delivering information,  Number of contract seed farming formalized | | |
| 7.5 Human | Capacity to experiment | | # of new technologies being tested at household level | | focus group discussions | | | Baseline survey | | | Endline survey | | |
|  | | | | | | | | | | | | | |
| 8. How will scaling be achieved? | | | | | | | | | | | | | |
| Scaling will be done through the involvement of the Direction Nationale de l’Agriculture (DNA), Women in Agriculture Development (ON Women), key-value chain actors, and other NGOs in the implementation of activities. Farmers will be linked to credit institutions and Village Savings and Loans Associations where they can contribute to and access credit to facilitate production. A value chain platform will be created which will be led by the DNA and quarterly meetings will be organized for knowledge sharing. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 9. How are the activities in this protocol linked to those of others? | | | | | | | | | | | | | |
| This activity is also linked to the nutrition sub-activity MA1114-21: Promote the empowerment of youth and women through radio for improved nutrition outcomes. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 10. Custom indicators | | | | | | | | | | | | | |
| * Number of value chain actors trained * Number of farmers attending the sessions organized by the platform disaggregated by sex and age * Number of partnership and market linkages formalized | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 11. Impact-based summary matrix | | | | | | | | | | | | | |
| 11.1 What is the development challenge you are addressing?  Weak relationship between smallholder vegetable farmers and key actors in the vegetable value chain within the Northern sector of Ghana | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 12. Budget (US$) | | | | | | | | | | | | | |
| Outcome/Output/Activity | | | | Sub-activity | | | Budget line | | WorldVeg | | | | |
| Outcome 3/Output 1/  Activity 2 | | | | MA3121-21 | | | Personnel | | 6,000 | | | | |
| Services | | 10,030 | | | | |
| Supplies | | 6,000 | | | | |
| Capital | | 0 | | | | |
| Travel | | 5,000 | | | | |
| Subtotal | | 27,030 | | | | |
| Overhead (18.2%) | | 4,919 | | | | |
| Total | | 31,949 | | | | |

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| 13. Gantt Chart | | | | | | | | | | | | |
| Year/Month | 2021 | | | | 2022 | | | | | | | |
| Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
| Linkages created (contracts formalized for seed delivery (i) by seed enterprises and agro dealers to beneficiaries, (ii) by outgrowers to seed enterprises (iii) under supervision or involvement of DNA, UN Women and NGOs |  |  |  |  |  |  |  |  |  |  |  |  |
| Baseline Survey conducted |  |  |  |  |  |  |  |  |  |  |  |  |
| Community forums organized |  |  |  |  |  |  |  |  |  |  |  |  |
| Women and youth involved in seed & inputs value chain through seed production of key vegetable species |  |  |  |  |  |  |  |  |  |  |  |  |
| Knowledge and information shared |  |  |  |  |  |  |  |  |  |  |  |  |
| Final report submission and data upload in DataVerse |  |  |  |  |  |  |  |  |  |  |  |  |

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| **Africa RISING W. Africa Activity Protocol – Outcome 3: MA3212-21** | | | | | | | | | |
| Outcome 3: Farmers and other value chain actors have greater and equitable access to production assets and markets (input and output) through enabling institutions and policies | | | | | | | | | |
| a. Output 3.2 | Options to expand accessibility of production assets and increase participation in household decision-making by disaggregated groups by gender | | | | | | | | |
| b. Activity 3.2.1 | Identify constraints to, and opportunities for increasing women and youth access to production assets in the target area | | | | | | | | |
| c. Sub-activity MA3212-21 | Co-identify value chain-based scaling pathways for irrigation technologies and water solutions with farmers and other actors of vegetable value chains in the Africa RISING sites in Mali | | | | | | | | |
|  | | | | | | | | | |
| d. Research team | | | | | | | | | |
| Name | Institution | | Role | | | | | | |
| Thai Minh | IWMI | | The Senior researcher: responsible for the systemic analysis of the scaling pathway for irrigated vegetable value chain in Ghana and Mali. She will carry out data collection and analysis on SI indicators mainly on social and human condition to evaluate holistic sustainability of the interventions | | | | | | |
| National Researcher Scaling Innovations (TBD) | IWMI | | The National Researcher will support the data collection on the systemic analysis component. | | | | | | |
| Jean Baptiste Tignegre | World Veg | | Contribution on vegetable value chain | | | | | | |
| Benedict Boyubie | IITA | | Support towards meeting project M&E requirements and FtF indicators while ensuring data upload on Dataverse | | | | | | |
| Birhanu Zemadim | ICRISAT-Mali | | Contribution on sub-activity conducted in Mali | | | | | | |
|  |  | |  | | | | | | |
| e. Student(s) | | | | | | | | | |
| Name | Institute | | Degree | | | | Start | End | |
|  |  | |  | | | |  |  | |
| f. Location(s) | National Level in Mali | | | | | | | | |
|  |  | | | | | | | | |
| g. Start | January 2021 | | | | | | | | |
|  |  | | | | | | | | |
| h. End | July 2022 | | | | | | | | |
|  | | | | | | | | | |
| 1. Justification | | | | | | | | | |
| Farmer investment in irrigation depends on income from the sale of irrigated crops for re-investing in irrigation and inputs (pumps, fertilizers, improved seeds, pesticides) to raise productivity (Adela et al., 2019[[96]](#footnote-97); de Bont et al., 2019[[97]](#footnote-98) and 2019a[[98]](#footnote-99)). Irrigation technology supply and services as well as access to well-established and profitable output markets need to collide for farmers to see the value of investing in irrigation for their production system. Access to the output market for agricultural products is a major factor determining farmers’ adoption of irrigation technologies. To support systemic scaling of technologies, it is essential to conduct an irrigated value chain analysis.  Specifically, the value chain analysis aims at understanding primary products and production-related factors to enhance sustainable production systems, market structure for agricultural products be produced and marketed in the chain, and the chain structure. The production system analysis emphasizes primary resources required for production, environmental consequences of resource exploitation, primary productivity, potential incomes generated for primary producers, and factors facilitating and inhibiting the production (Herman and Minh, 2020[[99]](#footnote-100)). The market analysis provides an understanding of market demands and requirements for products to be successfully produced and marketed in the chain. The chain structure analysis investigates the chain’s functions, potential actors’ roles and relevant knowledge and experience, value addition and distribution, and governance to determine how to organize the chain. Within the systemic scaling approach, irrigated value chain analysis can generate a better understanding of the level of entrepreneurship, gender, and social inclusion barriers to entrepreneurship and the mechanisms by which scaling of appropriate irrigation technology can be better integrated into the value chains.  Currently, IWMI is implementing several related initiatives on the co-identification of the value chain scaling pathway to operationalize the systemic scaling approach at the grassroots level. These works have been done under the scope of the Africa RISING project in Ethiopia. In Mali, ILSSI and SaWEL (the Safeguarding Sahelian Wetlands for Food Security) projects have established the ecological sustainable agricultural water management (ESAWM) multi-stakeholder platform[[100]](#footnote-101). The facilitation emphasizes private sector engagement into the ESAWM multi-stakeholder platform to foster interactive learning and adaptive scaling of agricultural water management solutions. Leveraging ongoing projects’ efforts, IWMI proposes the research on contextualizing the systemic scaling for irrigation technologies in respect of relevant AR-specific value chains in targeted regions or districts in Mali and linking these activities with the ESAWM multi-stakeholder dialogues to accelerate the impact of scale. | | | | | | | | | |
|  | | | | | | | | | |
| 2. Objectives | | | | | | | | | |
| 2.1 Understand value chain-based scaling potentials for irrigation technologies and water solutions along irrigated vegetable value chains | | | | | | | | | |
|  | | | | | | | | | |
| 3. Research questions | | | | | | | | | |
| 3.1. How the systemic scaling of irrigation technologies and water solutions can be injected into the agricultural value chains for sustainable intensification? | | | | | | | | | |
|  | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | |
| An action research approach will be used for research on Bhungroo and solar-based energy under the different drip irrigation systems (GH1222-21), enabling environment, and value-chain-base scaling pathway for irrigation technologies. The action research consists of four interrelated steps: analyze, co-design and test, reflect and act, and engage[[101]](#footnote-102). The analysis step includes a rapid assessment by an inter-disciplinary team from IWMI, using various methods such as semi-structure interviews with farmers and value chain actors, focus groups discussion with farmers, Water User Association, cooperative and cooperative union, in a combination with field observation and transaction walks, and consultation workshops with local relevant stakeholder. The assessment aims to:   * Investigate existing irrigation technologies and practices and farmers’ interests and willingness to adopt, * Understand irrigated value chain structure and function, * Investigate irrigation supply and output market, * Characterize the enabling environment at the local level, and * Identify technology opinions and scaling pathways.   In the co-develop step, stakeholder consultation workshops on scaling of water innovation within irrigated agricultural value chain will be organized to:   * Explore further the challenges, technology and scaling options/possibility, * Explore possibilities to scale the demonstrated irrigation practices/technology to other irrigation schemes within community, from one community to other communities, and from one district to others, * Investigate conditions for successful scaling of irrigation practices, * Identify key value chain actors to be involved to enhance the successful scaling and how to involve them, * Identify local partners for collaboration in the scaling of water innovations, and * Plan the implementation of the demonstration and scaling possibilities with stakeholders.   The reflect step will be undertaken by the research team throughout the testing process to:   * Gather and analyze feedbacks from farmers and partners participating in the testing of demonstration and scaling pathways and integrating them into adapting the tested pathways, * Reflect on tested technologies and scaling pathway, how to continue with the tested scaling pathway, how local partners and participants appreciate the scaling approach, and how they react to it, * Incorporate these reflections into the new scaling pathways to be tested in the future, and * Prepare for the further stakeholder engagement process (see the next step).   The engage step will also be carried out throughout the action research process, aiming to interact with stakeholders and participants of the testing process, engage with the existing innovation platforms and multi-stakeholder dialogues at local and national level, and identify and involve new relevant actors and stakeholders. Specific activities in the engage step include, but not limited to:   * Organize technology awareness campaigns in the villages together with development agents, department/office of agriculture at district and regional levels and NGOs; * Link Africa Rising’s scaling pilots with ILSSI multi-stakeholder dialogues around SSI; * Engage private sector in demonstrating and supplying technologies within the communities and into the ESAWM multi-stakeholder platform; and * Share experience and lessons learned with the relevant multi-stakeholder platforms. | | | | | | | | | |
|  | | | | | | |  | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | Responsibility | | |
| * Vegetable value chain’s actors, their roles, and their relationships in the chain * Activities carried out by actors * Local input supply systems * Farmers’ production system and marketing channels * Local collection/trading systems * Vegetable market structure, demand and supply, opportunities, and trends * Private sector actors involved in supplying irrigation equipment/water solutions * Irrigation technology and water solutions for scaling   Scaling options for Irrigation technology and water solutions | | | | | | | IWMI | | |
|  | | | | | | | | | |
| 6. Milestones | | | | | | | | | |
| Deliverables | | | | Means of verification | | | End date | | |
| 6.1 Qualitative dataset on technology and scaling option and vegetable value chains in Mali | | | | Dataverse | | | Sep. 2021 | | |
| 6.2 Report on the technology and scaling pathways co-identified two AR sites Mali | | | | Project report to be published in CGSpace submitted to IITA | | | Mar. 2022 | | |
| 6.3 The ESAWM multi-stakeholder dialogues meeting reports | | | | The report to be published on ILSSI Website submitted to IITA | | | Based on actual events to be organized | | |
| 6.3 Paper based on this year’s data and research on systemic scaling of irrigation technologies and water solutions along irrigated value chains | | | | Correspondence with Journal about submission | | | Jul. 2022 | | |
|  | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | |
| Domain | Indicator | Metrics/Scale | | | Approach used | Before intervention | | | After intervention |
| 7.1 Productivity |  |  | | |  |  | | |  |
| 7.2 Environmental |  |  | | |  |  | | |  |
| 7.3 Economic |  |  | | |  |  | | |  |
| 7.4 Social | Social cohesion | Participation in community activities  Level and reliability of social support | | | Key informant Interviews;  Focus group discussion; consultation workshop |  | | |  |
| 7.5 Human | Collective action | Participation in collective action group | | |  |  | | |  |
|  | Capacity to experiment | # of new practices being tested | | | Interviews; Focus group discussion; consultation workshop |  | | |  |

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| 8. How will scaling be achieved? |
| Scaling will be achieved by a series of stakeholder engagements and system scaling activities, including, but not limited to:   * Using co-generation of knowledge through on-farm demonstration to scale out innovative technologies; * Organizing stakeholder meetings with farmers and extension officers on the results of the trials and the preferred water lifting and application methods during the dry season; * Sharing research results and engaging with potential scaling partners such as regional offices of the Ministry of Food & Agriculture (MoFA) and other relevant government organizations once the technologies and scaling pathways are co-identified and verified; * Linking AR’s irrigation technology and value chain-based scaling pilots with relevant multi-stakeholder dialogues/platforms to integrate the scaling into the platforms’ agendas and to facilitate the systemic changes and capacity to enhance the scaling of irrigation technologies and water solutions * Developing and using fact sheets, workshops, policy briefs, as well as scientific papers to communicate to the wider public actors, practitioners, and relevant stakeholders * Facilitate private sector engagement into ESAWM multi-stakeholder platform/dialogue and scaling of the ESAWM innovation (co-leveraging with ILSSI and SaWEL). |
|  |
| 9. How are the activities in this protocol linked to those of others? |
| This sub-activity experiment is linked to other work conducted by IWMI on water use within vegetable production systems. In addition, it is linked to sub-activities planned by the World Vegetable Centre under MA1115-21 and MA1116-21, and by STEPRI on policy and institutional analysis. The outcomes of this research will help to disseminate irrigated vegetable production in Mali. |
|  |
| 10. Custom indicators |
| * Number of demonstrations established * Number of farmers trained * Number of field days organized * Number of meetings/workshops attended * Number of project reports produced * Number of 1 journal article submitted/published |
|  |
| 11. Impact-based summary matrix |
| 11.1 What is the development challenge you are addressing?  This sub-activity will address the following major development challenges:   * highly vulnerable to the effects of climate change, while farmers are cultivating in marginal lands with low and erratic and are exposed to more frequent and longer dry spells and floods that threaten food security. * Social and gender norms hindering social inclusion, together with limitation in the physical environment obstruct the investment and expansion of irrigation. * Along the agricultural value chain, constraints to smallholders’ access to water management technologies and equipment as well as investment to irrigation include under-developed irrigation value chains and capacities, under-developed irrigation supply chain, limited access to finance, energy, knowledge services to invest in irrigation, and weak input and output market linkages; * Government policies and programs are biased towards large-scale irrigation and production system and lag behind efforts of smallholder farmers and the private sector in AWM.   11.2 Who is your target audience, e.g. extension agents, farmers, or policy makers?  The most important audience include small-scale farmers, women and youth involving in farming, extension and development agents, policymakers and the private sector who are working on irrigation and solar-powered products. |

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| 12. Budget | IWMI Mali |
| Personnel | 11,200 |
| Services | 56,265 |
| Supplies | 0 |
| Capital | 0 |
| Travel | 9,100 |
| Overhead | 14,548 |
| Total | 91,113 |

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| 13. Gant chart | | | | | | | | | | | | | |
| Year/ Month | 2021 | | | | | | 2022 | | | | | | |
| Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul |
| Co-identify scaling pathways (incl. vegetable value chain analysis, farmer engagement, need assessment, training ) |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Facilitating local stakeholders to carry on the value chain-based scaling pathways |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Multi-stakeholder dialogues and engagement |  |  |  |  |  |  |  |  |  |  |  |  |  |
| M&E for verification |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Facilitate private sector engagement into ESAWM multi-stakeholder platform/dialogue and scaling of the ESAWM innovation (co-leveraging with ILSSI and SaWEL) |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Reflection, data analysis and report writing |  |  |  |  |  |  |  |  |  |  |  |  |  |

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| **Africa RISING West Africa Activity Protocol – Outcome 4: MA4111-21** | | | | | | | | | | | | | | | | | |
| Outcome 4: Effective partnerships are built with farmers, local communities, and research and development partners in the private and public sectors to ensure delivery and uptake at scale of SI technologies, innovations and practices | | | | | | | | | | | | | | | | | |
| a. Output 4.1 | | | | Alliances and effective partnerships developed between farmers, local communities, and research and development agents in the public and private sectors to enable the release, dissemination, and adoption of proven technologies and practices to scale | | | | | | | | | | | | | |
| b. Activity : 4.1.1 | | | | Conduct cost-benefit and gender analyses coupled with other socio-economic analyses to identify and quantify adoption constraints and opportunities for different farmer contexts | | | | | | | | | | | | | |
| c. Sub-activity MA4111-21 | | | | Evaluate the impact of Africa RISING investment on the Return on Investment (ROI) | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | | | | |
| Name | | | | Institution | | | | Role | | | | | | | | | |
| Bekele Kotu | | | | IITA | | | | Agricultural economist, research design, data analysis and writing | | | | | | | | | |
| Julius Manda | | | | IITA | | | | Agricultural economist, research design, data analysis and writing | | | | | | | | | |
| Felix Badolo | | | | ICRISAT | | | | Agricultural economist, research design, data analysis and writing | | | | | | | | | |
| Carlo Azzarri | | | | IFPRI | | | | Agricultural economist, research design, paper revision | | | | | | | | | |
| Oyinbo Oyakhilomen | | | | University Ahmadu Bello University | | | | Agricultural economist/consultant, data processing and analysis | | | | | | | | | |
| Abdul Rahman Nurudeen | | | | IITA | | | | Agronomist, expert consultation on technology selection and data, Ghana | | | | | | | | | |
| Birhanu Zemadim | | | | ICRISAT | | | | NRM scientist, expert consultation on technology selection and data, Mali | | | | | | | | | |
| Fred Kizito | | | | IITA | | | | NRM scientist, expert consultation on technology selection, Ghana | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | | | | |
| Name | | | Institute | | | | Degree | | | | | Start | | | | | End |
|  | | |  | | | |  | | | | |  | | | | |  |
|  | | | | | | | | | | | | | | | | | |
| f. Location(s) | | Mali | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | |
| g. Start | | June 2021 | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | |
| h. End | | June 2022 | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | | | | |
| Agricultural productivity growth has long been recognized as one of the most important and effective pathways through which agricultural research and technologies can increase rural incomes, food security and reduce poverty. To this end, the Africa RISING project has been testing, validating, and promoting improved sustainable intensification technologies to sustainably increase agricultural productivity, food and nutrition security, and reduce poverty. The AR project has led to the development and diffusion of improved agricultural technologies representing a major scientific and policy achievement in east and southern Africa. Despite these achievements, rigorous impact evaluation has not been done to investigate the impact of these interventions on the return to investment (ROI) and household welfare. The AR project has been validating SI technologies through farmer-managed on-farm trials in Malawi, Ghana, Mali, and Tanzania. Contour bunding technique (CBT) is a well-known method in Mali for reducing water runoff and for controlling soil erosion. The application involves the creation of permanent contour ridges covered with perennial grasses, whereby farmers follow the ridges to prepare the farm plot for crop production (Zemadim *et al*., 2015[[102]](#footnote-103)). Other potential benefits of CBT are improving crop yields and household food security (Traoré *et al*., [2017](https://link.springer.com/article/10.1007/s10668-018-0144-9#ref-CR46)[[103]](#footnote-104)). However, there is little evidence on assessing the potential economic impacts of the CBT. This study will evaluate the potential (ex-ante) impacts of CBT on ROI to guide further investments in research and extension. To date, no study has been conducted to estimate the impact of the adoption of the AR technologies particularly CBT on ROI and indicators of household welfare such as household income, food security, and poverty. In estimating the adoption effects on the selected outcome variables, we will follow and adapt earlier work in the vein[[104]](#footnote-105). | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | | | | |
| To examine the ex-ante impacts of Africa RISING investment on ROI, especially the case of CBT in Mali | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | | | | |
| 3.1 What is the potential impact of CBT promoted by Africa RISING on financial return on investment for the farmer who invests in them? | | | | | | | | | | | | | | | | | |
| 3.2 Have the CBT promoted by Africa RISING increased the financial return of smallholder farmers invested in the technologies? | | | | | | | | | | | | | | | | | |
| 3.3 What is the Return on Investment of CBT in Mali? | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | | | | |
| The data for analysis will come from on-farm trials and demonstration plots conducted in AR intervention villages. Specifically, data on inputs, input costs, and productivity of CBT will be obtained from the Africa RISING scientists and implementing partners in Mali. Coupled with this, the costs of investments will be obtained from the approved budgets from the Africa RISING project management and accounts. Moreover, data from the Africa RISING baseline and end-line surveys will be used. To estimate the potential economic impacts of CBT, the Economic Surplus Model (ESM)(Asfaw *et al*., 2009[[105]](#footnote-106); Kleemann *et al*., 2014[[106]](#footnote-107); Udry *et al*., 2006[[107]](#footnote-108); Alene *et al.*, 2009[[108]](#footnote-109); Alston *et al.,* 1995[[109]](#footnote-110)) will be used. We will focus on the calculation of financial return on investment. | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | | | | Responsibility/Institute | | | | |
| The study will be based on existing databases | | | | | | | | | | | | | Bekele Kotu/IITA | | | | |
|  | | | | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | | | | |
| Deliverables | | | | | | | | | Means of verification | | | | | | Delivery date | | |
| 6.1 Technical report | | | | | | | | | Link to online platforms (e.g CGSpace) | | | | | | Apr. 2022 | | |
| 6.2 Journal article submitted for publication. Title: Evaluate the ex-ante impact of Africa RISING investment on the Return on Investment (ROI): Case of Contour Bunding Technique in Mali | | | | | | | | | Notification from journal | | | | | | Apr. 2022 | | |
| 6.3 Information brief shared with the wider audience | | | | | | | | | Link to the online platform (AR website, CGSpace, etc.) | | | | | | Jun. 2022 | | |
| 6.4 Webinar presentation | | | | | | | | | Link to webinar slides | | | | | | Jul. 2022 | | |
|  | | | | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | | | | |
| Domain | Indicator | | | | Metrics/Scale | | | | | Approach  used | | | | Before intervention | | After intervention | |
| Economic | Profitability | | | | Net income ($/ha) | | | | | The study will be based on existing database | | | | Low net income of farmer per unit of land  Sorghum production without contour bunding generated a net benefit of FCFA 120,665 (US$ 201) per hectare with a production cost of FCFA 34,000 (US$ 57)  US$ 220 (Birhanu et al., 2018[[110]](#footnote-111)) | | High net income | |
|  | | | | | | | | | | | | | | | | | |
| 8. How will scaling be achieved? | | | | | | | | | | | | | | | | | |
| This study focuses on the impact of Africa RISING technologies on return on investment by smallholder farmers. We hope that the results of the study will help the government and non-governmental development organizations to prioritize technologies for scaling. To this effect, the implementing team intends to release an information brief and share it with various stakeholders. | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | |
| 9. How are the activities in this protocol linked to those of others? | | | | | | | | | | | | | | | | | |
| The study assesses the impact of Africa RISING technologies on returns to investment. Thus, it has direct links with research activities associated with the technologies selected for analysis. | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | |
| 10. Custom indicators | | | | | | | | | | | | | | | | | |
| * Number of published papers in peer-reviewed journals * Number of conference presentationsNumber of Information briefs with relevant recommendations for targeting adoptable interventions | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | |
| 11. Impact-based summary matrix | | | | | | | | | | | | | | | | | |
| 11.1 What is the development challenge you are addressing?  The AR project has been validating SI technologies through farmer-managed on-farm trials in Malawi, Ghana, Mali, and Tanzania. The SI technologies which have been validated range from soil enhancing and water conservation technologies such as ISFM, improved germplasm (maize, sorghum, millet, and legume varieties) to improved postharvest technologies. Results based on these trials generally show that these technologies are essential in increasing the productivity and profitability of the cereal and legumes production system. However, research focusing on assessing the potential economic impacts of these technologies is lacking. This study will evaluate the potential (ex-ante) impacts of selected AR technologies on ROI to guide further investments in research and extension. | | | | | | | | | | | | | | | | | |
| 11.2 Who is your target audience, e.g., extension agents, farmers, or policymakers?  Our study targets government and non-government organizations working on smallholder agriculture, agricultural researchers, and farmers. | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | |
| 12. Budget (US$) | | | | | | | | | | | | | | | | | |
| Outcome/Output/Activity | | | | | | Sub-activity | | | | | Budget line | | | ICRISAT | | | IITA |
| Outcome 4/Output 1/Activity 1 | | | | | | MA4111-21 | | | | | Personnel | | | 13,500 | | | 5,000 |
| Services | | | 2,500 | | | 2,000 |
| Supplies | | | 0 | | | 0 |
| Capital | | | 0 | | | 0 |
| Travel | | | 0 | | |  |
| Sub-total | | | 16,000 | | | 7,000 |
| Overhead (17%) | | | 2,720 | | |  |
| **Total** | | | 18,720 | | | 7,000 |
| Grand Total | | | | | | | | | | | 25,720 | | | | | | |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 13. Gant Chart | | | | | | | | | | |
| Year/Month | 2021 | | | | | | 2022 | | | |
| Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
| Data organization and analysis |  |  |  |  |  |  |  |  |  |  |
| Drafting paper |  |  |  |  |  |  |  |  |  |  |
| Revising paper and submission to journal |  |  |  |  |  |  |  |  |  |  |

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| **2021/22 Africa RISING West Africa Activity Protocol – Outcome 4: MA4312-21** | | | | | | | | | | | | | |
| Outcome 4: Effective partnerships are built with farmers, local communities, and research and development partners in the private and public sectors to ensure delivery and uptake at scale of SI technologies, innovations, and practices | | | | | | | | | | | | | |
| a. Output 4.3 | | | | A framework for monitoring and evaluating technology adoption, and technology-associated risk accessible to the project team and scaling partners | | | | | | | | | |
| b. Activity 4.3.1 | | | | Monitor and modify the progress of technology adoption process towards scaling | | | | | | | | | |
| c. Sub-activity MA4312-21 | | | | Assess the impact of Innovation Platforms on SI technology uptake in Africa RISING interventions communities | | | | | | | | | |
|  | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | |
| Name | | | Institution | | | Rôle | | | | | | | |
| Bougouna Sogoba | | | AMEDD | | | Activity leader | | | | | | | |
| Mahamadou Dicko | | | AMEDD | | | Data analysis and reporting | | | | | | | |
| Bouba Traore | | | ICRISAT | | | Scientific advice on technology adoption | | | | | | | |
| Benedict Boyubie | | | IITA | | | Monitoring and evaluation/data management | | | | | | | |
|  | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | |
| Name | | Institute | | | | | | Degree | | Start | | End | |
|  | |  | | | | | |  | |  | |  | |
|  | | | | | | | | | | | | | |
| f. Location(s) | | Koutiala and Bougouni | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| g. Start | | September 2019 | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| h. End | | June 2022 | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | |
| During phase I of the Africa RISING project in Mali, four Innovation Platforms (Ips) were established; two at the communal level and two at the district level. These IPs were used for learning, information exchange, and technology dissemination. In 2019/2020, data analysis was finalized, and results revealed that technology adoption was dynamic and depended on the availability of technology at an affordable cost, its easiness of application, and social acceptability. In 2021/2022 a manuscript will be developed considering the impact of the developed IPs in technology dissemination and impact on strengthening and sustaining multi-stakeholder innovation platforms. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | |
| 2.1 To assess the impact of Innovation Platforms on farmers’ access to information and SI technology uptake | | | | | | | | | | | | | |
| 2.2 To improve adoption of SI innovation in intervention communities through advanced co-learning and exposure to validated technologies /innovations | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | |
| 3.1 What are the roles of innovation platforms vis-à-vis increased farmers’ awareness and adoption of validated technologies? | | | | | | | | | | | | | |
| 3.2 To what extent did Innovation Platforms work during the first phase of Africa RISING and improved farmers' access to information on SI technologies and SI technology dissemination? | | | | | | | | | | | | | |
| 3.3 How would the lessons learned from innovation platforms feed into multi-stakeholder interest group meetings and help women and youth farmers to access SI innovations? | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 4. Procedures (survey methods, stakeholder meetings, etc.) | | | | | | | | | | | | | |
| Focus group discussion and key informant interviews were conducted to assess the impact of innovation platforms on beneficiaries’ access to information and scaling of SI technologies in 2019/2020. Multi-stakeholder meetings were conducted in the four technology parks and at district level to understand knowledge gained from IPs and increase awareness of farmers on SI innovations. Information from farmer-to-farmer exchange visits and farmer field days were collected on the awareness of SI options. The activity for the year 2021/2022 will be consolidating the outputs and writing a manuscript for publication. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | | Responsibility/Institution | | |
| Is the collected data part of a multi-year experiment/trial? Yes | | | | | | | | | | |  | | |
| No new data is to be collected | | | | | | | | | | |  | | |
|  | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | |
| Deliverables | | | | | | | Means of verification | | | | | Delivery date | |
| 6.1 Publication on impact of IPs in technology dissemination and impact on strengthening and sustaining multi-stakeholder innovation platforms | | | | | | | Confirmation of manuscript submission to the journal of Agriculture and Food Security | | | | | May 2022 | |
| 6.2 Finalization of the West Africa Handbook chapter in collaboration with the co-authors as a team | | | | | | | Handbook revisions | | | | | Oct. 2021 | |
|  | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators and metrics | | | | | | | | | | | | | |
| Domain | Indicator | | | | Metrics/Scale | | | | Approach  used | | Before intervention | | After intervention |
| 7.1 Productivity | Farmer perceptions and ratings of technology yield performance | | | | Kg (yield, fodder, residue) / ha / season | | | | Survey | | The adoption rate of improved organic fertilizer and contour bunding technology is in the range of 10 to 15 % in Bougouni and 12 to 18% in Koutiala. | | The upgraded improved fertilizer is adopted in all villages by 81% to 100% (Koutiala), 81% to 96% (Bougouni). The contour bunding (CBT) is adopted by 46% to 86% in Koutiala district, while it is adopted by 65% to 87% in Bougouni district. |
| 7.2 Environment | Farmer perceptions of vegetative cover | | | | % vegetative and tree cover | | | | Survey | | Vegetation and tree cover is in the order of 25 to 35% in both Bougouni and Koutiala districts | | Vegetation and tree cover reduced 7.69 % to 13.9% in both Koutiala and Bougouni districts. |
| 7.4 Social | Active innovation platforms | | | | Number of IPs established | | | | Survey | | None | | There were four IPs established. The IPs contributed to significant changes in behaviour and livelihoods at the individual, organization and community level. Improvements in crop yield, household nutrition, women access to agricultural land, inputs and capacity building were cited by respondents as significant changes brought by the IPs. |
|  | | | | | | | | | | | | | |
| 8. How will scaling be achieved? | | | | | | | | | | | | | |
| The results of the impact assessment will improve multi-stakeholder platform meetings and increase uptakes of technologies and innovations in intervention communities while farmers' field days will increase the exposure of producers to SI technologies and increase their adoption by the latter. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 9. How are the activities in this protocol linked to those of others? | | | | | | | | | | | | | |
| This activity is linked to activities that are conducted in the technology parks and intervention villages. IPs are channels through which demand-driven action research is conducted and research results are communicated to village communities through the IP channel. Hence this work plan is related to all implemented activities. | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 10. Custom indicators | | | | | | | | | | | | | |
| Number of publications in journals | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | |
| 11. Impact-based summary matrix | | | | | | | | | | | | | |
| 11.1 What is the development challenge you are addressing?  The development challenge being addressed by this sub-activity is understanding the role of innovation platforms for technology scaling and how the knowledge gained from innovation platforms spill over to multi-stakeholder interest groups. | | | | | | | | | | | | | |
| 11.2. Who is your target audience, e.g., extension agents, farmers, or policymakers?  Extension agents, farmers, researchers and policymakers. | | | | | | | | | | | | | |

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| 12. Budget | | | |
| Outcome/Output/Activity | Sub-activity | Budget line | AMEDD |
| Outcome 4/Output 3/Activity 1 | MA4312-21 | Personnel | 10,000 |
| Services | 7,500 |
| Supplies | 8,000 |
| Capital | 0 |
| Travel | 8,000 |
| Subtotal1 | 33,500 |
| Overhead (AMEDD 10%) | 3,350 |
| Subtotal2 | 36,850 |
| Overhead (ICRISAT 17%) | 6265 |
|  |  | Total | 43,115 |

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| 13. Gantt chart | | | | | | | | | | | |
| Year/month | 2021 | | | | | | 2022 | | | | |
| Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May |
| Continuing literature review and refining of data for publication |  |  |  |  |  |  |  |  |  |  |  |
| Data analysis |  |  |  |  |  |  |  |  |  |  |  |
| Preparation of a technical report |  |  |  |  |  |  |  |  |  |  |  |
| Finalization of West Africa Handbook chapter |  |  |  |  |  |  |  |  |  |  |  |
| Manuscript production and submission to journal |  |  |  |  |  |  |  |  |  |  |  |

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| **2021/22 Africa RISING West Africa Activity Protocol – Outcome 4: MA4313-21** | | | | | | | | | | | | | | | | | | |
| Outcome 4: Effective partnerships to ensure delivery and large-scale uptake of SI technologies and practices are established with farmers, local communities, and research and development partners in the private and public sectors. | | | | | | | | | | | | | | | | | | |
| a. Output: 4.3 | | | | An updated framework for monitoring technology adoption to be used by the project team and scaling partners available and accessible | | | | | | | | | | | | | | |
| b. Activity 4.3.1 | | | | Monitor and modify the progress of technology adoption process towards scaling | | | | | | | | | | | | | | |
| c. Sub-activity MA4313-21 | | | | Mapping trends of rainfall onsets, cessation and length of rainy season in Segou, Sikasso, and Mopti regions | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | | | | | |
| Name | | | Institution | | | | Rôle | | | | | | | | | | | |
| Bougouna Sogoba | | | AMEDD | | | | Activity Leader | | | | | | | | | | | |
| Francis Muthoni | | | IITA | | | | Contribute to rainfall trend analysis | | | | | | | | | | | |
| Mahamadou Dicko | | | AMEDD | | | | Data formatting and analysis | | | | | | | | | | | |
| Benedict Boyubie | | | IITA | | | | Monitoring and evaluation/data management | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | | | | | |
| Name | | Institute | | | | | | Degree | | | Start | | | | | End | | |
|  | |  | | | | | |  | | |  | | | | |  | | |
|  | | | | | | | | | | | | | | | | | | |
| f. Location(s) | | Segou, Sikasso and Mopti | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | |
| g. Start | | July 2018 | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | |
| h. End | | June 2022 | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | |
| 1. Justification | | | | | | | | | | | | | | | | | | |
| Technology adoption by farmers is linked not only to changes in environmental, climate variations but also to the household socio-economic status and the cultural acceptance of technologies. The reliability and replicability of the technologies depend on the specific context where technologies are developed and implemented. In the year 2019/2020, available technologies developed in phase I of the Africa RISING project and technologies validated in phase II were mapped and characterized using GIS and remote sensing technologies. Activities completed include change detection analysis on land use, land cover status from 2013 to 2018, and technology adoption status per village in the districts Bougouni and Koutiala. In the year 2020/2021 outputs of the GIS and remote sensing were analyzed and two manuscripts are under preparation. The manuscripts integrate change detection information along with gender influence in technologies uptake under different agro-ecological and socio-economic contexts. The manuscripts also include social and economic assessments for single and multiple technology adopters. To improve the content of the manuscripts it was agreed to include analysis of trends of rainfall onsets, cessation, and length of rain season from the long-term data obtained from Sikasso, Segou, and Mopti regions. | | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | | | | | |
| 2.1 To map and characterize Africa RISING technologies under different agro-ecologies and socio-economic settings. | | | | | | | | | | | | | | | | | | |
| 2.2 To assess gender influence in technology adaptation and use. | | | | | | | | | | | | | | | | | | |
| 2.3 To assess the social and economic impact of multiple interventions vis a vis of single intervention in target communities. | | | | | | | | | | | | | | | | | | |
| 2.4 To evaluate how the cereal and legume value chains have to function to ensure ecological and socio-economic resilience. | | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | | | | | |
| 3.1 To which extent Africa RISING technologies have been adopted under different socio-economic and environmental conditions in Mali? | | | | | | | | | | | | | | | | | | |
| 3.2 How does gender influence technology adaptation and use in intervention communities? | | | | | | | | | | | | | | | | | | |
| 3.3 What are the social and economic impacts of multiple interventions vis a vis of single intervention in target communities? | | | | | | | | | | | | | | | | | | |
| 3.4 What is the gap in the cereal and legumes value chains for resilience upgrading? | | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | | | | | |
| The activity is a continuation of GIS and Remote sensing change detection analysis conducted in 2019/2020. Additional information on land use in 2019 was included. Vector data (road, market, villages, water site) will be applied to better understand the site context of technology adoption. For each technology developed by the project the coordinates of farmers who participated in technology adoption were projected on the developed map to analyze the spatial context of adoption. In the different villages, socio-economic data on the households’ conditions and analyzed data on gender influence in technology uptake was used along with GIS-derived bio-physical information to develop manuscripts. In the year 2021/2022 additional data on long-term rainfall records will be analyzed to determine region-wise rainfall onsets, cessation, and length of rain season. | | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | | | | Responsibility/Institution | | | | | |
| Is the collected data part of a multi-year experiment/trial? Yes | | | | | | | | | | | | |  | | | | | |
| 5.1 GIS data on roads, markets, villages, and water bodies | | | | | | | | | | | | | Bougouna Sogoba/AMEDD | | | | | |
| 5.2 Secondary data on technology adoption from Africa RISING database and previously published resources | | | | | | | | | | | | | Mahamadou Dicko/AMEDD | | | | | |
|  | | | | | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | | | | | |
| Deliverables | | | | | | | | | Means of verification | | | | | | Delivery date | | | |
| 6.1 GIS maps showing the spatial extent of technology adoption | | | | | | | | | Maps uploaded on DataVerse | | | | | | Dec. 2020 (Delivered) | | | |
| 6.2 Manuscript on gender-disaggregated technology adoption for the two agro-ecologies in Koutiala and Bougouni districts | | | | | | | | | Confirmation of manuscript submission to Sustainability journal | | | | | | Feb. 2022 | | | |
| 6.3 Finalization of the West Africa Handbook in collaboration with the co-authors as a team | | | | | | | | | Handbook revisions | | | | | | Dec. 2021 | | | |
|  | | | | | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators and metrics | | | | | | | | | | | | | | | | | | |
| Domain | Indicator | | | | Metrics/Scale | | | | | | | Approach used | | | Before intervention | | | After intervention |
| 7.1 Productivity | Yield,  Cropping intensity (annual count) | | | | Net primary productivity (t/ha) at landscape level.  # Crops grown per year across a landscape.  Plant population density of crops within a landscape | | | | | | | Survey data,  RS images | | | Primary productivity is less than 30% of the potential  # major Crops grown are three cereals (maize, sorghum, millet) and two legumes (groundnut and cowpea) and cotton. Plant population density ranges from 40 to 60%. | | |  |
| 7.2 Environmental | Vegetative Cover | | | | % Vegetative and tree cover at landscape scale | | | | | | | RS images | | | Vegetation and tree cover is in the order of 25 to 35% in both Bougouni and Koutiala districts | | | Vegetation and tree cover reduced to 7.69 % to 13.9% in both Koutiala and Bougouni district. |
| 7.3 Economic | Profitability,  Variability of profitability | | | | Contribution to regional or national GDP | | | | | | | Survey data | | | Contribution of crops production to the national GDP is in the range of 40 to 55%. | | |  |
| 7.4 Social | Equity (Gender, Marginalized groups),  Level of social cohesion | | | | Variability and distributions of productivity, income and assets  Active farmer groups  Active innovation platforms at landscape scale | | | | | | | Survey data | | | All farm based crops productivity is controlled by the head of the household who is a man. In female headed households productivity is controlled by women. There is only one active farmer group in Bougouni. There were no innovation platforms in both districts before the project intervention. | | |  |
| 7.5 Human | Nutrition,  Nutrition Awareness | | | | Landscape supply of diverse foods (natural areas) – not on-farm  % hh with adequate nutrition knowledge at landscape scale | | | | | | | Survey data National database | | | The landscape supply of diverse food is in the range of 20 to 35% in both districts. An average of 25% of hh have adequate nutrition knowledge. | | |  |
|  | | | | | | | | | | | | | | | | | | |
| 8. How will scaling be achieved? | | | | | | | | | | | | | | | | | | |
| The determination of the analogue sites and the adoption or adaptation condition will help to better orient the scaling up of different technologies developed by Africa RISING. | | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | |
| 9. How are the activities in this protocol linked to those of others? | | | | | | | | | | | | | | | | | | |
| Remote sensing and GIS will be used to map uptake of technologies conducted in the different sub-activities in Mali | | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | |
| 10. Custom indicators | | | | | | | | | | | | | | | | | | |
| * Number of hectares under each technology * Number of farmers adopting specific technologies * Number of technologies available for dissemination * Two publications | | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | |
| 11. Impact-based summary matrix | | | | | | | | | | | | | | | | | | |
| 11.1 What is the development challenge you are addressing?  The development challenge being addressed by this sub-activity is understanding the agro-ecological classes where adoption of Africa RISING technologies took place | | | | | | | | | | | | | | | | | | |
| 11.2 Who is your target audience, e.g. extension agents, farmers, or policymakers?  Extension agents, farmers, researchers, and policymakers. | | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | |
| 12. Budget (US$) | | | | | | | | | | | | | | | | | | |
| Outcome/Output/Activity | | | | | | Sub-activity | | | | Budget line | | | | AMEDD | | | IITA | |
| Outcome 4/Output 3/Activity 1 | | | | | | MA4313-21 | | | | Personnel | | | | 12,000 | | | 10,000 | |
| Services | | | | 4,000 | | | 0 | |
| Supplies | | | | 3,000 | | | 0 | |
| Capital | | | | 0 | | | 0 | |
| Travel | | | | 4,000 | | | 0 | |
| Subtotal1 | | | | 23,000 | | | 10,000 | |
| Overhead (AMEDD 10%) | | | | 2,300 | | | 0 | |
| Subtotal2 | | | | 25,300 | | | 10,000 | |
| Overhead (ICRISAT 17%) | | | | 4,301 | | |  | |
|  | | | | | |  | | | | Total | | | | 29,601 | | | 10,000 | |
| Total | | | | | | 39,601 | | | | | | | | | | | | |

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| 13. Gantt Chart | | | | | | | | | | | | |
| Year/Month | 2021 | | | | | | 2022 | | | | | |
| Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
| Finalization of the West Africa Handbook chapter |  |  |  |  |  |  |  |  |  |  |  |  |
| Literature review |  |  |  |  |  |  |  |  |  |  |  |  |
| Rainfall trend analysis |  |  |  |  |  |  |  |  |  |  |  |  |
| Finalization of socio-economic data analysis |  |  |  |  |  |  |  |  |  |  |  |  |
| Manuscript preparation and submission |  |  |  |  |  |  |  |  |  |  |  |  |

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| **2021/22 Africa RISING West Africa Activity Protocol – Outcome 4: MA4411-21** | | | | | | | | | | | | | | |
| Outcome 4: Effective partnerships to ensure delivery and large-scale uptake of SI technologies and practices are established with farmers, local communities, and research and development partners in the private and public sectors | | | | | | | | | | | | | | |
| a. Output 4.4 | | | Knowledge sharing centers and learning alliances within existent local and regional institutions including development actors developed | | | | | | | | | | | |
| b. Activity 4.4.1 | | | Establish knowledge-sharing and learning alliances among scaling actors | | | | | | | | | | | |
| c. Sub-activity MA4411-21 | | | Manage the operations of four technology parks as hubs for innovation, research, extension, advisory, coordination, and demonstration in Bougouni and Koutiala | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| d. Research team | | | | | | | | | | | | | | |
| Name | Institution | | | Role | | | | | | | | | | |
| Birhanu Zemadim | ICRISAT | | | Activity leader | | | | | | | | | | |
| Tumaini Sidibe | FENABE | | | Bougouni site coordinator and facilitator of multi-stakeholder interest group meeting | | | | | | | | | | |
| Mahamadou Dicko | AMEDD | | | Koutiala site coordinator and facilitator of multi-stakeholder interest group meeting | | | | | | | | | | |
| Karamoko Sanogo | ICRISAT | | | Data manager | | | | | | | | | | |
| Benedict Boyubie | IITA | | | Monitoring and evaluation/data management | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| e. Student(s) | | | | | | | | | | | | | | |
| Name | Institute | | | | | Degree | | | Start | | | | End | |
|  |  | | | | |  | | |  | | | |  | |
|  | | | | | | | | | | | | | | |
| f. Location(s) | Bougouni and Koutiala districts | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| g. Start | April 2017 | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| h. End | March 2022 | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 1. Justification: | | | | | | | | | | | | | | |
| The Mali Africa RISING project is coordinated by ICRISAT in close collaboration with partner institutes. Four technology parks were established, two in Bougouni (Flola and Diaba villages), and two in Koutiala (M’Pessoba and N’Golonianasso villages). These parks have been used by participating institutes (ICRISAT, ICRAF, ILRI, WorldVeg, IER, and AMEDD) to conduct controlled research experiments. Training programs have been conducted in the parks for local NGOs, national training centers, and communities living in Africa RISING intervention villages. The parks have been used by other programs like the West Africa sorghum improvement program, the sorghum and millet dissemination project (ARDT\_SMS), and the groundnut improvement program for capacity building and outreach activities. Also, the establishment of the parks has integrated research and capacity-building activities by the different project partners, for example by the UNDP land management program and the AfDB funded TAAT program. From phase I of the program, it was understood that the long-term sustainability of running innovation platforms was not very likely. In this case, the four technology parks have been utilized to conduct multi-stakeholder interest group meetings and this is to continue in the current year and beyond. Emphasis will be given to engaging more youth in research and scaling activities. During the 2021/2022 season, the goal is to formalize and hand over the four parks as unique community-level multi-stakeholder platforms for all programs conducted in the specific districts. It has been agreed that the parks in Madina and Flola of Bougouni district will be managed by FENABE and parks in M’Pessoba and N’Golonianasso in Koutiala district will be managed by AMEDD. The two local institutions; FENABE and AMEDD have greatly been part of the social mobilization and R&D research activities in the districts of Bougouni and Koutiala. ICRISAT and Africa RISING project partners in Mali (ILRI, IER, and others.) will provide scientific backstopping and capacity-building activities in the parks in the years 2021/2022 and beyond in close consultation with FENABE and AMEDD. Additionally, the work conducted in these technology parks will feed into the i-REACH initiative coordinated by the Sustainable Intensification Innovation Lab (SIIL). Similar efforts are being conducted in Ghana and vital cross-shared lessons around the management and overall learning process on the Technology Park model will emerge across the two countries. | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 2. Objectives | | | | | | | | | | | | | | |
| 2.1 Conducting integrated and multi-disciplinary research and scaling strategy on sustainable intensification program. | | | | | | | | | | | | | | |
| 2.2 Developing a research hub for validating Africa RISING technologies for wider dissemination, providing capacity building and short-term training programs. | | | | | | | | | | | | | | |
| 2.3 Provide a site for the multi-stakeholder interest group meeting. | | | | | | | | | | | | | | |
| 2.4 Provide information concerning proven technological practices and climate services to farmers, local NGOs, and extension agents. | | | | | | | | | | | | | | |
| 2.5 Provide high-quality agricultural inputs (plant material, fertilizer, etc.), and climate-smart water access facilities to farmers. | | | | | | | | | | | | | | |
| 2.6 Share cross-learning across Ghana and Mali Technology Parks | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 3. Research questions | | | | | | | | | | | | | | |
| 3.1 How suitable are technology parks as means for demonstration and experimentation? | | | | | | | | | | | | | | |
| 3.2 What are the mechanisms involved when working with development partners to ensure success and innovation? | | | | | | | | | | | | | | |
| 3.3 How can progress towards scaling be tracked and monitored and feedback received to inform the research components on what is working and what is not applicable? | | | | | | | | | | | | | | |
| 3.4 How can the partnership model on inclusive monitoring and evaluation conducted by scaling actors be implemented in other areas beyond Mali? | | | | | | | | | | | | | | |
| 3.5 What lessons can we learn between Ghana and Mali Technology parks in the context of management and dissemination of information to end-users? | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 4. Procedures (survey methods, gender disaggregation, treatments, experimental design, sample size, etc.) | | | | | | | | | | | | | | |
| The four technology parks will be utilized by the research team for various research and dissemination strategies. At each site, scientists and implementing partner institutes will identify and determine the size of the field plot to implement the field trials. Training programs will be provided to participating farmer groups (particularly the youth and women groups) on the introduced technology before activity implementation. With the use of these technology parks and independently identified farmers’ fields, and according to the phase II proposal we are expecting to reach 4,910 households through research and capacity building activities in the year 2021/2022. Identified best-bet technologies will be scaled to approximately 22,952 households through development actors who are working with the Africa RISING program. The socio-economy group will monitor the adoption of identified technologies in farmers’ fields and conduct continuous monitoring and evaluation of the five sustainable intensification domains. In each technology park, a farmer field day will be organized to bring various groups of farmers (adult, youth, women, etc.) together and create an opportunity to discuss the types of technologies introduced, the relevance and challenges among the farmer groups. Approximately 300 farmers are expected in each of the farmer field days and one-third of the invitee would be youth farmers. | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 5. Data to be collected and uploaded on Dataverse | | | | | | | | | | Responsibility/Institution | | | | |
| Is the collected data part of a multi-year experiment/trial? Yes | | | | | | | | | |  | | | | |
| 5.1 All field trial data that include agronomic, land, soil, and water management | | | | | | | | | | Karamoko Sanogo/ICRISAT | | | | |
| 5.2 All data related to training and farmers' field visit | | | | | | | | | | Karamoko Sanogo, Bouba Traore/ICRISAT | | | | |
|  | | | | | | | | | | | | | | |
| 6. Milestones | | | | | | | | | | | | | | |
| Deliverables | | | | | Means of verification | | | | | | | Delivery date | | |
| 6.1 Biophysical database on improved technological practices and participatory research in the technology parks | | | | | Implemented trials, metadata, and database uploaded on DataVerse | | | | | | | May 2022 | | |
| 6.2 Manuscript on approach to technology parks use, technology validation and dissemination, capacity building, and lessons from farmers’ field visit | | | | | Confirmation of manuscript submission to Agriculture and Food Security journal | | | | | | | Mar. 2022 | | |
| 6.3 Finalization of the West Africa Handbook chapter in collaboration with the co-authors as a team | | | | | Handbook revisions | | | | | | | Dec. 2021 | | |
|  | | | | | | | | | | | | | | |
| 7. Sustainable intensification indicators | | | | | | | | | | | | | | |
| Domain | | Indicator | | | | | Metrics/Scale | Approach used | | | Before intervention | | | After intervention |
| 7.1 Productivity | | N/A | | | | |  |  | | |  | | |  |
| 7.2 Environment | | N/A | | | | |  |  | | |  | | |  |
| 7.3 Economic | | N/A | | | | |  |  | | |  | | |  |
| 7.4 Social | | Social cohesion,  Collective action | | | | | % of community members participating in some form of social group at landscape level,  Participation in a collective action group at household level | Survey data | | | There has been no utilization of contour bunding technology and sack gardens in Africa RISING intervention villages prior to intervention. | | | Nearly 28 % (in Bougouni) and 32 % (in Koutiala) of community members participated in constructing contour bunding lines at a landscape level. Percentage of household engagement in the utilization of sack gardens and composting was 11% in Bougouni and 14% in Koutiala. |
| 7.5 Human | | Capacity to experiment | | | | | Number of new practices being tested by type at farm level  Number of farmers experimenting  Number of men and women literate  Number of men and women with numeracy | Survey data | | | Practices before intervention were purely farmers led | | | After the project intervention there are more than 15 new practices/technologies tested and validated by the project.  During the reporting year, a total of 450 farmers (35% women) experimented technologies in the parks.  During the reporting season a total of 2500 farmers (50% women) become literate on improved agricultural technologies and NRM practices either through direct participation or indirectly through farmer to farmer learning and FFD. |
|  | | | | | | | | | | | | | | |
| 8. How will scaling be achieved? | | | | | | | | | | | | | | |
| The technology parks are sites for technological innovation, demonstration and capacity building. Best-bet technological innovations will be scaled-up to farmers’ fields through farmers exchange visits and implementation of trials at farmers’ fields. Hence, technology parks are considered as ideal sites where scaling work starts. | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 9. How are the activities in this protocol linked to those of others? | | | | | | | | | | | | | | |
| The proposed crop-livestock activities in the current work plan were previously implemented in the technology parks and will be implemented in the same technology parks. | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 10. Custom Indicators | | | | | | | | | | | | | | |
| * Number of trainings conducted * Number of farmers trained (gender-disaggregated) * Number and types of technologies implemented * Number of visits made by development institutions * Number of farmers, field extension agents, and service techniques and other actors visited the parks during farmer field days | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | |
| 11. Impact based summary matrix | | | | | | | | | | | | | | |
| 11.1 What is the development challenge you are addressing?  In rural Mali, technology adoption is hampered by the lack of reliable technological validation options that include researcher-developed technologies, farmers’ awareness of the developed technologies, farmers’ technical skills in adopting developed technologies and social and behavioral links among researchers, farmers and extension agents. On-station developed technologies will be reaching the farmers through technology parks developed within the agro-ecologies of farmers’ settings. Technology parks are also equipped with training facilities to provide the required technological trainings. This approach is ideal to introduce farmers to the developed technology and sensitize them through awareness programs to support the adoption of technologies. | | | | | | | | | | | | | | |
| 11.2 Who is your target audience, e.g., extension agents, farmers, or policymakers?  The target audiences are farmers, extension agents, development projects working on resilience strategies. | | | | | | | | | | | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 12. Budget (US$) |  |  |  |  |  |
| Outcome/output/activity | Sub-activity | Budget line | ICRISAT | AMEDD | FENABE |
| Outcome 4/Output 4/Activity 1 | Sub-activity MA4411-21 | Personnel | 39,000 | 2,500 | 2,500 |
| Services | 5,500 | 1,000 | 1,000 |
| Supply | 3,500 | 1,000 | 2,000 |
| Travel | 6,500 | 2,000 | 2,000 |
| Capital | 0 | 0 | 0 |
| Subtotal1 | 54,500 | 6,500 | 6,500 |
| Overhead (10%) |  | 650 | 650 |
| Overhead (17%) | 9,265 | 7,150 | 7,150 |
| Total | 63,765 | 8,366 | 8,366 |
| Grand total | 80,497 | | |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 13. Gantt chart | | | | | | | | | |
| Year/month | 2021 | | | | | | 2022 | | |
| Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar |
| Contribute towards development of the West Africa Handbook |  |  |  |  |  |  |  |  |  |
| Running integrated and multi-disciplinary research and scaling strategy |  |  |  |  |  |  |  |  |  |
| Data collection |  |  |  |  |  |  |  |  |  |
| Conduct multi-stakeholder interest group meeting |  |  |  |  |  |  |  |  |  |
| Organizing field day |  |  |  |  |  |  |  |  |  |
| Farmers’ feedback session on the technologies |  |  |  |  |  |  |  |  |  |
| Manuscript preparation and submission |  |  |  |  |  |  |  |  |  |

## Mali consolidated budget 2021-2022 (US$)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sub-activity** | **Leader** | **ICRISAT** | **WorldVeg** | **IITA** | **IER** | **WUR** | **AMEDD** | **IWMI** | **FENABE** | **Total** |
| MA1111-21: Evaluating crop simulation models using different fertility sources and climate model outputs to improve the productivity of sorghum | ICRISAT | 56,160 |  |  |  |  | 10,296 |  | 10,296 | 76,752 |
| MA1112-21: Understanding soil fertility management in cereal cropping systems in southern Mali | ICRISAT | 58,500 |  |  |  |  | 10,296 |  |  | 68,796 |
| MA1113-21: Testing adaptation of dual purposes sorghum hybrids in Mali to diversify options for crop-livestock integration | ICRISAT | 59,329 |  |  |  |  |  |  |  | 59,329 |
| MA1114-21-2: Evaluate and disseminate technologies to control vegetable pests and diseases, reduce postharvest losses, and improve human nutrition | WorldVeg |  | 43,734 |  |  |  |  |  |  | 43,734 |
| MA1131-21: Risk management and informed decision-making towards sustainable intensification of crop-livestock systems | WUR |  |  |  |  | 27,144 |  |  |  | 27,144 |
| MA1211-21: Determination of cropping management factors using empirical relations, GIS, and Remote Sensing tools in two agro-ecologies in Mali | ICRISAT | 56,160 |  |  |  |  |  |  |  | 56,160 |
| MA1212-21: Improving crop-livestock productivity and household income through the use of contour bunding and agroforestry options | IER |  |  |  | 40,085 |  |  |  |  | 40,085 |
| MA1221-21: Improved irrigation technologies for efficient and sustainable agricultural water management in rural Mali | ICRISAT | 50,895 |  |  |  |  |  |  |  | 50,895 |
| ***Sub-total Outcome 1*** |  | *281,044* | *43,734* | *-* | *40,085* | *27,144* | *20,592* | *-* | *10,296* | *435,258* |
| MA2221-21: Train farmers on management of postharvest and processing technologies | WorldVeg |  | 11,820 |  |  |  |  |  |  | 11,820 |
| ***Sub-total Outcome 2*** |  |  | *11,820* |  |  |  |  |  |  | *11,820* |
| MA3112-21 Analyze the enabling environment including policies and institutional arrangements and intervention to identify factors that enable the inclusion of women and youth along irrigated vegetable value chain | IWMI |  |  |  |  |  |  | 9,599 |  | 9,599 |
| MA3121-21 Assessing the inclusiveness of women and youth within the vegetable production value chain to enhance vegetable production among smallholder farmers. | WorldVeg |  | 31,949 |  |  |  |  |  |  | 31,949 |
| MA3212-21 Co-identify value chain-based scaling pathways for irrigation technologies and water solutions with farmers and other actors of vegetable value chains in the Africa RISING sites in Mali and Ghana and link these sites and activities to ILSSI’s multi-stakeholder Dialogue Space on small scale irrigation in Mali | IWMI |  |  |  |  |  |  | 91,113 |  | 91,113 |
| ***Sub-total Outcome 3*** |  |  | *31,949* |  |  |  |  | *100,712* |  | *136,584* |
| MA4111-21: Evaluate the impact of Africa RISING investment on the Return on Investment (ROI) | ICRISAT | 18,720 |  | 7,000 |  |  |  |  |  | 25,720 |
| MA4312-21: Assess the impact of Innovation Platforms on SI technology uptake in Africa RISING intervention communities | AMEDD |  |  |  |  |  | 43,115 |  |  | 43,115 |
| MA4313-21: GIS mapping of implemented technologies across different agro-ecologies and gender influence in technology adaptation and use in Bougouni and Koutiala districts of Mali | AMEDD |  |  | 10,000 |  |  | 29,601 |  |  | 39,601 |
| MA4411-21: Operation of four technology parks as hubs for research and dissemination in Bougouni and Koutiala | ICRISAT | 63,765 |  |  |  |  | 8,366 |  | 8,366 | 80,497 |
| ***Sub-total Outcome 4*** |  | 82,485 |  | 17,000 |  |  | 81,082 |  | 8,366 | 188,933 |
| Allocation for graduate study  Moumini Guindo (PhD candidate)  Karamoko Sanogo (PhD candidate)  Cheick Oumar Dembele (PhD candidate)  Gilbert Dembele (MSc candidate)  Sery Coulibali (MSc candidate)  Moussa Camara (BSc candidate)  Raki Diallo (PhD candidate) |  | 11,555 |  |  |  |  |  |  |  | 11,555 |
| **Total** |  | **375,084** | **87,504** | **17,000** | **40,085** | **27,144** | **101,674** | **100,712** | **18,662** | **767,865** |

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